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TECHNICAL MANUAL

for

RADAR TEST SET AN/UPM-98A

DEPARTMENT OF THE NAVY
NAVAL ELECTRONIC SYSTEMS COMMAN

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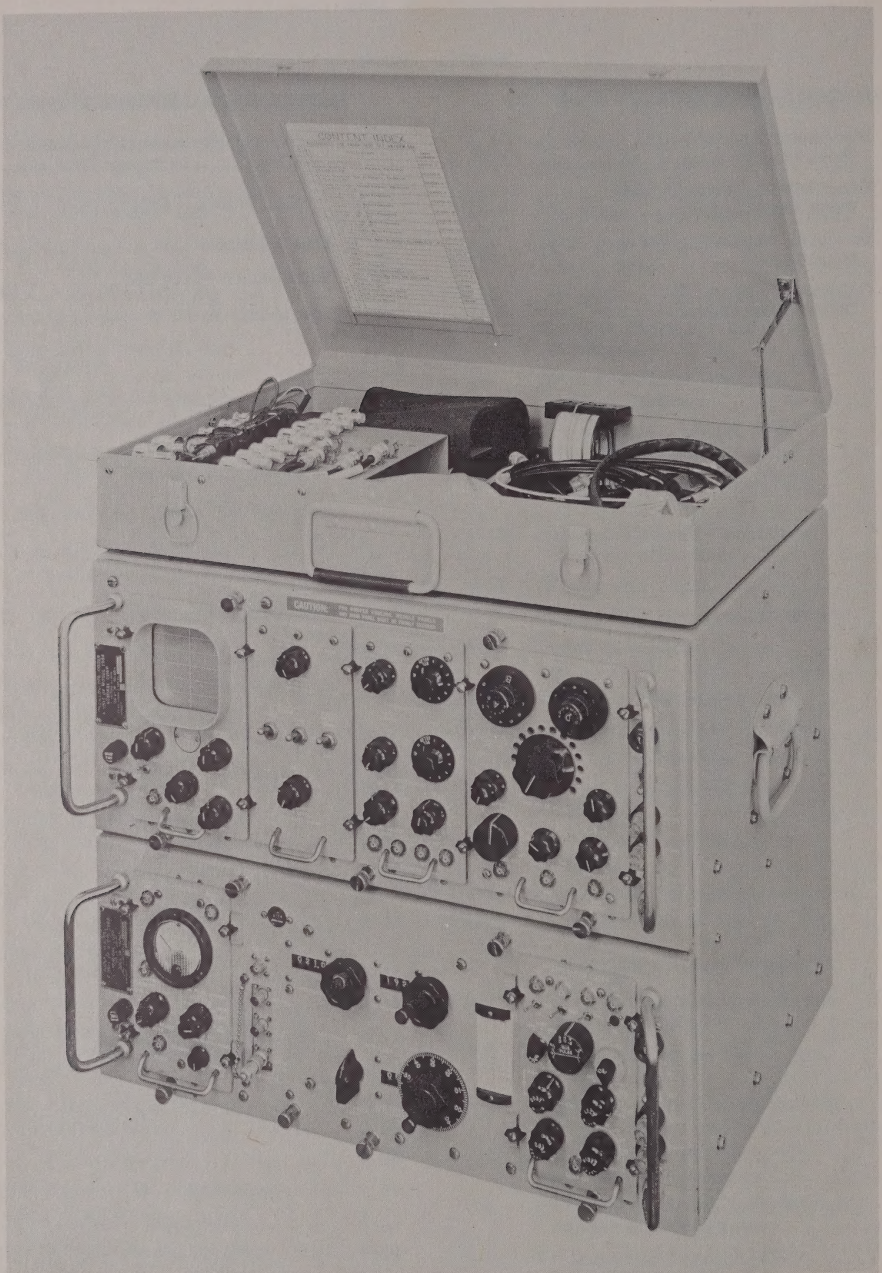


Figure 1-1. Radar Test Set AN/UPM-98A

SECTION 1

GENERAL INFORMATION

1-1. GENERAL DESCRIPTION

a. PHYSICAL CHARACTERISTICS. - Figure 1-1 shows the complete Radar Test Set AN/UPM-98A which is a transportable test set for use with secondary radar equipment. It consists of two drawer-type main assemblies, Radar Test Set TS-1253A/UP and Coder Simulator SM-197A/UPM-98, both mounted in Electrical Equipment Case CY-2726A/UPM-98. The wiring, terminal strips, and connectors needed for distribution of power and synchronizing signals to the various circuits are contained in the chassis of these drawers. The ac and dc voltages for operation of the circuits are supplied by a separate power supply in each drawer. Each of the two drawer assemblies contains several plug-in units. Those located in the upper drawer (Radar Test Set TS-1253A/UP) are the Display unit, the Sweep and Intensity Mark unit, the Crystal Mark and Sync unit, and the SIF Coder. Those located in the lower drawer (Coder Simulator SM-197A/UPM-98) are the Calibration-Control unit and the Interrogation Coder. All operating controls and switches, connectors, indicators, and fuses are located on the front panels of the assemblies. Details on the circuits and their functions will be given later in this manual.

b. ELECTRICAL CHARACTERISTICS. - Radar Test Set AN/UPM-98A performs the following basic functions:

(1) It produces signals (both rf and video) simulating "challenge" (interrogation) signals transmitted by Mark X IFF (Identification: Friend or Foe), SIF (Selective Identification Feature) interrogators. A simulated ISLS (Interrogation Side Lobe Suppression) reference pulse may be added to the interrogation signals when desired. These outputs can be used in testing equipment designed to receive these types of signals.

(2) It produces signals (both rf and video) simulating the replies transmitted by IFF/SIF transponders. Both mode identification pulses and reset tag pulses may be added to the reply video. A delayed interleaved reply signal is provided to simulate multiple reply reception. These can be used in testing equipment designed to receive these types of signals.

(3) It provides an oscilloscope facility for displaying signals from equipment under test and from the test set itself.

(4) It produces synchronizing trigger pulses for use by external equipment and by the test set oscilloscope.

(5) It demodulates pulse-coded rf signals from transmitters under test, producing pulsed video outputs.

(6) It produces a positive suppressor pulse output for use in "gating off" circuits under test.

(7) It measures the frequency of rf signals by means of a resonant cavity wavemeter.

(8) It measures the pulse repetition frequency (prf) of pulse signals of the types used in IFF/SIF systems.

(9) It produces a calibrated signal for making minimum discernible signal (MDS) checks, and for measuring signal levels by the comparison method.

(10) It measures the peak power of rf signals.

(11) It provides a precision 1030 mHz rf signal from a crystal controlled oscillator for use as a calibrating signal.

(12) It decodes mode 4, 3-pulse replies, producing a single pulse output.

1-2. OUTPUT SIGNALS AVAILABLE FROM THE AN/UPA-98A.

The signals supplied by the AN/UPM-98A include those listed below:

a. Mark X coded interrogation signals (video and rf).
b. SIF coded reply signals (video and rf).
c. Interleaved SIF coded reply signals (video and rf).
d. Trigger pulses (zero delay and variable delay).
e. Calibrated video pulses.
f. ISLS pulses for use with interrogation signals.
g. Mode identification pulse signals for use in "tagging" reply video.
h. Reset tag pulse signal simulating the interrogator receiver "end of receiver on time" pulse signal.
i. Suppressor pulse signal to gate off circuits under test.
j. Mode 4 reply decode single output pulse.

1-3. DESCRIPTION OF UNITS.

a. RADAR TEST SET TS-1253A/UP. - Radar Test Set TS-1253A/UP, shown in figure 1-2, provides special facilities for simulation of the coded pulse train signals produced as replies by SIF transponders. It also provides oscilloscope facilities for video analysis and signal tracing. Radar Test Set TS-1253A/UP contains the following plug-in units:

(1) DISPLAY UNIT. - This unit provides an "A" type display of the video signals on a 4-inch

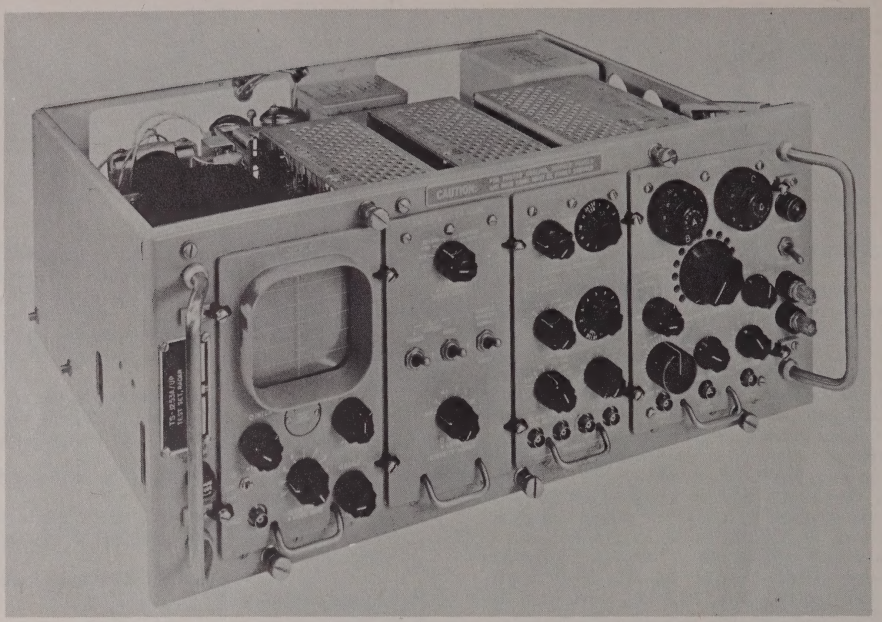


Figure 1-2. Radar Test Set TS-1253A/UP

cathode ray tube. A graduated scale on the CRT face may be illuminated to enhance readability. Panel controls permit adjustment of focus, intensity, centering, sensitivity, and scale illumination. Video signals to be displayed are fed in through a BNC-type panel connector. A toggle switch allows the operator to select either a high or low termination for the video input line.

(2) SWEEP AND INTENSITY MARK UNIT.- This unit generates sweep signals for the oscilloscope, and also produces intensity gate pulse signals and intensity modulation time markers for use on the oscilloscope. Panel controls permit selection of sweep durations ranging from 1 to 20,000 microseconds. Two momentary-contact toggle switches on the front panel permit temporary return of the sweep or trigger to the zero time reference position and the display of a marker to indicate the start of the delayed sweep or trigger. Intensity markers with various spacings may be superimposed upon the display trace. A toggle switch permits the operator to start these marks in coincidence with either the sweep or system trigger.

(3) CRYSTAL MARK AND SYNC UNIT. - This unit generates crystal-controlled time markers for use on the display oscilloscope. It also produces triggers (both delayed and undelayed) for display oscilloscope synchronization and provides controlled delay of the oscilloscope sweep signal. A panel switch permits the operator to trigger the equipment either internally or externally. The sweep trigger and the equipment synchronizing trigger may be delayed independently from 1 to 750 microseconds. The crystal controlled markers are displayed along with the input video on a time-sharing basis, above the video trace. When internally triggered, a control permits setting the system prf between 15 pps and 4100 pps. Trigger signals are available at panel connectors for external use. A connector is also provided for triggering the test set from an external trigger source.

(4) SIF CODER. - This unit generates signals which simulate SIF code trains. In addition to the pulses normally found in SIF reply signals, the SIF coder permits the insertion of the "X" pulse and the "ID" pulse (sometimes called "IP" for "Identification of Position") for tests requiring them. Any of the pulses in the train except the first bracket pulse and the ID pulse can be omitted and substituted with a special pulse which is separately variable in position for test purposes. The SIF coder is also capable of simulating a condition in which two signals reach a receiver at almost the same time so that two interleaved pulse trains are present. By proper adjustment, a type of garbled signal may be simulated in which one of the pulses of the second train falls in the space exactly 1.45 microsecond after the last pulse in the first train, causing confusion in the decoding process. These signals may be used for checking the capability of a decoder to decode two interleaved trains and to block (or "degarble") two garbled (overlapped) trains. The SIF coder normal output (variable amplitude) is fed out through one panel connector, while a separate (fixed amplitude)

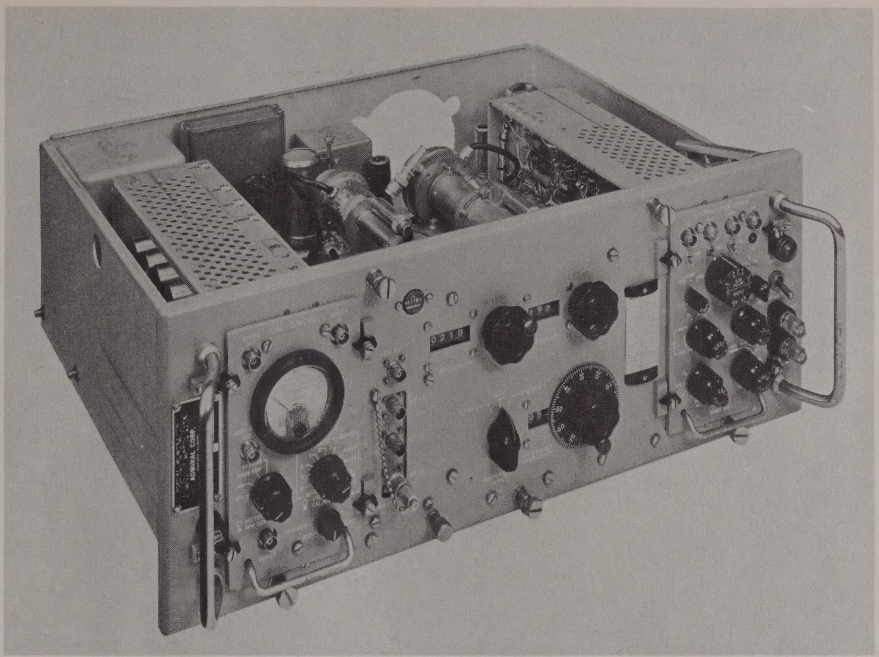


Figure 1-3. Coder Simulator SM-197A/UPM-98

output is made available for such uses as modulating the interrogation coder.

b. CODER SIMULATOR SM-197A/UPM-98. - The Coder Simulator assembly shown in figure 1-3 comprises the lower drawer. Several functional sections are mounted directly on the assembly chassis in a fixed manner while two other sections are designed as plug-in units. A "time operated" (elapsed time) indicator is located on the front panel. The fixed sections include an rf section which is made up of an oscillator (rf signal generator), a variable attenuator, and a wavemeter. The output level and frequency of the signal generator are adjustable. An ALC (Automatic Level Control) circuit maintains a constant output level. Modulation is normally provided by the Interrogation Coder or SIF Coder. The plug-in units are described below:

(1) CALIBRATION - CONTROL UNIT. - The Calibration Control unit produces a calibrated pulse output signal. It contains circuitry for automatic signal level control and metering circuits for indicating wavemeter resonance. The meter is also used to give an indication of the prf of pulse signals being counted. The Calibration-Control unit also contains the mode 4 reply decoding circuitry.

(2) INTERROGATION CODER. - This unit generates simulated Mark X IFF interrogation signals. An ISLS pulse can be added to the basic interrogation signal when desired. The Interrogation Coder is capable of independently producing interrogations in modes 1, 2, 3/A and C. For mode 4 interrogations, the pulse modulating signal containing up to 33 pulses must be obtained from an external source. The four mode 4 synchronizing pulses which precede these are produced internally by this equipment. In addition, the Interrogation Coder produces reply mode identification pulses as follows: for mode 1, two pulses spaced 3 microseconds apart; for mode 2, two pulses spaced 5 microseconds apart; for mode 3/A, two pulses spaced 8 microseconds apart, and for mode C, two pulses spaced 21 microseconds apart. Also, a reset tag signal consisting of three pulses 8, 2, and 4 microseconds wide (spaced 2 and 3 microseconds apart) is available. The output pulses are routed internally to the signal generator modulator and are also available for external use at a front panel connector.

c. ELECTRICAL EQUIPMENT CASE CY-2726A/UPM-98. - Electrical Equipment Case CY-2726A/UPM-98, as shown in figure 1-4 is used for housing Radar Test Set TS-1253A/UP and Coder Simulator SM-197A/UPM-98. The case provides the necessary electrical interconnections between the major assemblies through two nine-contact connectors that mate with similar connectors in the major assemblies. A blower is mounted in the rear of the case on the right side to provide air circulation through the major assemblies.

d. ACCESSORIES CASE CY-2725/UPM-98. - The Accessories Case, shown in figure 1-5, is a

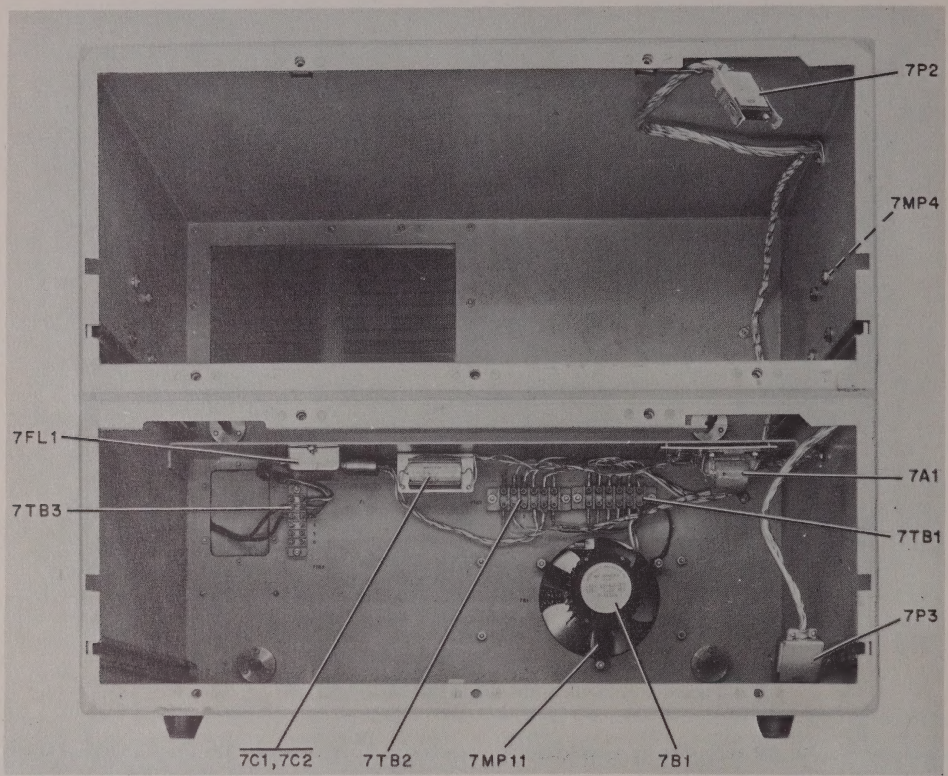


Figure 1-4. Electrical Equipment Case CY-2726A/UPM-98

carrying case for all AN/UPM-98A accessories listed in table 1-1.

e. ACCESSORIES

(1) TEST LEAD MX-2681/UP. - Test Lead MX-2681/UP shown in figure 1-6, is an oscilloscope attenuator probe which is supplied for signal-tracing video circuits. The test lead can be set for any one of three attenuation ratios of 1 to 1, 10 to 1, and 100 to 1. When desired, the pointed probe tip shown can be replaced with an alligator clip for more convenient connection to the circuit under test. When used with Radar Test Set AN/UPM-98A, the test lead is normally connected to the VIDEO input jack on the Display unit.

(2) VIDEO CABLES. - For the purpose of connecting video signals from equipment under test to the radar test set and making "patch" connections between units of the AN/UPM-98A, several CG-530B/U cable assemblies are supplied as listed in table 1-1. These are made up of RG-62/U type low-capacitance coaxial cable having a nominal impedance of 93 ohms and nominal capacitance of 13.5 pf per ft. Each cable assembly is equipped with two UG-260/U (BNC type) connectors.

(3) RADIO FREQUENCY CABLES. - For connecting radio frequency signals, two RG-58C/U cable assemblies are supplied; one 5 feet long and one 10 feet long. These cables have a nominal impedance of 50 ohms and a nominal capacitance of 29.5 pf per foot. Both cables are equipped with a UG-88F/U connector at each end. A length of RG-58C/U cable for "jumpering" the SG OUT connector to the SG IN connector is also provided.

(4) CONNECTOR ADAPTERS. - Five types of adapters (listed in table 1-1) are included for making connections between various types of connectors, using the video and rf cable assemblies supplied.

(5) ELECTRICAL DUMMY LOAD DA-232/U. - Two BNC-type plugs containing a 51 ohm resistor and designated with the nomenclature DA-232/U are supplied with the accessories. The purpose of these plugs is to properly terminate open-end rf transmission lines to prevent the formation of standing waves.

(6) SPECIAL SERVICING CABLES. - Four special-purpose servicing cable assemblies (figure 1-7) are supplied for connecting the plug-in units to their major assembly connectors when the units have to be operated outside of the drawer-chassis for

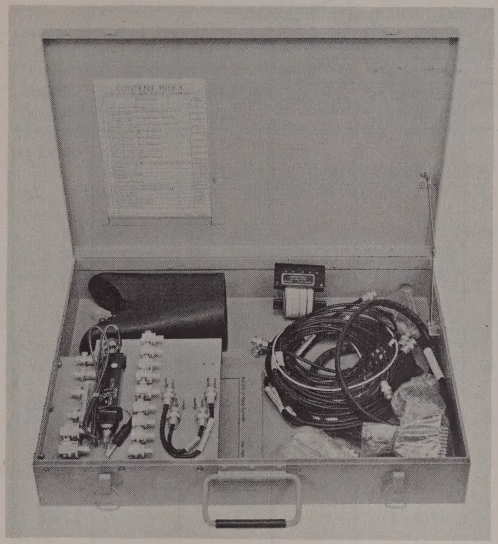


Figure 1-5. Accessories Case CY-2725/UPM-98

adjustment or for maintenance purposes. Cable Assembly CX-4963/UPM is for use on any of the four plug-in units of the TS-1253A/UP. Cable Assembly CX-4964/UPM is designed to provide extended connections between 1P3 on the Display unit and 2J2 on the Sweep and Intensity Mark unit of TS-1253A/UP. Cable Assembly CX-6092/U is for use with the two plug-in units of Coder Simulator SM-197A/UPM-98.

(7) CATHODE RAY TUBE VISOR MX-2953/UPM. - This visor fits over and clamps onto the lip around the opening for the cathode ray tube face on Display unit of TS-1253A/UP to shade the screen under bright light conditions.

(8) BOOK OF CALIBRATION CHARTS. - This book contains the correction and calibration curves to be used for accurately interpreting the wave-

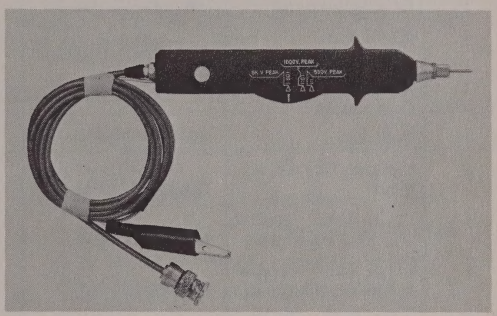


Figure 1-6. Test Lead MX-2681/UP

meter, demodulator, and rf oscillator frequency readings on the Coder-Simulator SM-197A/UPM-98.

(9) CALIBRATION CARD AND SPARES. - An easily replaceable card is attached to the front panel of the Coder Simulator SM-197A/UPM-98. This card provides space for recording twelve frequencies and their corresponding dial readings. Twelve spare

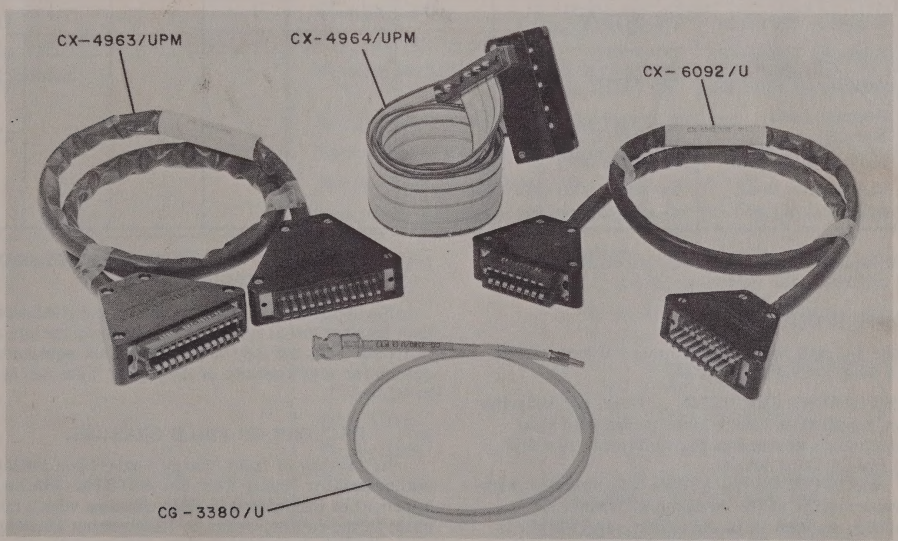


Figure 1-7. Servicing Cable Assemblies

Table 1-1. Radar Test Set AN/UPM-98A, Equipment Supplied

QTY PER EQUIP	NOMENCLATURE NAME	DESIGNATION	OVERALL DIMENSIONS (inches) HEIGHT	WIDTH or LENGTH	DEPTH	VOLUME (Cu ft)	WEIGHT (lbs)	REF DESIG
1	Radar Test Set, Consisting of:	AN/UPM-98A	19-5/8	23-3/4	19-3/4	5-1/2	153	
1	Radar Test Set	TS-1253A/UP						
1	Coder Simulator	SM-197A/UPM-98						
1	Electrical Equipment Case	CY-2726A/UPM-98						
1	Accessories Case, Containing:	CY-2725/UPM-98	4-3/4	22-5/8	16-1/2	1	37	
1	Test Lead	MX-2681/UP	1-1/2	72	1-3/4		1-1/4	6A1
1	Cathode Ray Tube Visor	MX-2953/UPM	2-1/2	6-1/8	8-3/4		1-1/4	11MP1
1	Cable Assy, Special Purpose Electrical	CX-4963/UPM		36-1/2				11W1
1	Cable Assy, Special Purpose Electrical	CX-4964/UPM		36-3/4				11W5
1	Cable Assy, Special Purpose Electrical	CX-6092/U		36				11W3
1	Cable Assy, RF	CG-409E/U		62-1/8				11W7
1	Cable Assy, RF	CG-409E/U		122-1/8				11W9
1	Cable Assy, RF	CG-1848/U		6-1/8				11W11
4	Cable Assy, RF	CG-530F/U		62				11W13
3	Cable Assy, RF	CG-530F/U		10				11W15
2	Adapter, Connector	UG-201/U						11CP2
2	Adapter, Connector	UG-273/U						11CP3
2	Adapter, Connector	UG-274B/U						11CP5
2	Adapter, Connector	UG-309/U						11CP1
2	Adapter, Connector	UG-636/U						11CP4
2	Dummy Load, Electrical	DA-232/U						11CP17
2	Technical Manual	Navships 0967-291-0010						
2	Maint. Stds Book	Navships 0967-291-0030						
1	Ref. Stds Sheet	Navships 0967-291-0020						

cards are included in the Accessories Case for use in different applications.

1-4. REFERENCE DATA.

Tables 1-2 and 1-3 provide quick reference data for Radar Test Set AN/UPM-98A.

1-5. EQUIPMENT SUPPLIED. - Table 1-1 lists the equipment supplied and the corresponding physical data. Dimensions are in inches, volume is in cubic feet, and weight is in pounds.

a. SHIPPING DATA. - Table 1-4 lists the physical characteristics of the equipment. Dimensions are in inches, volume is in cubic feet, and weight is in pounds. All data pertains to equipment crated and ready for shipment.

1-6. EQUIPMENT AND PUBLICATION REQUIRED BUT NOT SUPPLIED.

No additional equipment and no publications other than this technical manual are required for operation of Radar Test Set AN/UPM-98A. Test equipment required for maintenance of the Radar Test Set is listed in table 1-7.

1-7. FACTORY OR FIELD CHANGES.

No factory of field changes have been initiated or authorized for Radar Test Set AN/UPM-98A as of the approval of this manual. For changes which may exist in the future, refer to Electronics Maintenance Book (EMB), NAVSHIPS 0967-000-0000 for the complete field change index.

1-8. EQUIPMENT SIMILARITIES.

Radar Test Set AN/UPM-98A is basically similar to several other pieces of equipment. These equipments, along with their similarities and differences, are listed in table 1-5. The assemblies and subassemblies of Radar Test Set AN/UPM-98A are identified in table 1-6.

1-9. PREPARATION FOR RESHIPMENT.

To repackage the test set for shipment or storage, it is preferable to use the original containers and packaging, filler, blocking, and bracing materials, if they are available.

The Accessories Case CY-2725/UPM-98 contains compartments designed to accommodate all the accessories and handbooks supplied with the test set. See that all the accessories listed on the Contents Index Card in the Accessories Case are present and located in their proper positions.

If the Accessories Case has been attached to the top of the Electrical Equipment Case CY-2726A/UPM-98 during use of the equipment, it is not necessary to detach it. The test set can be safely shipped with both cases bolted together.

Table 1-2. Radar Test Set TS-1253A/UP Quick Reference Data

FUNCTION	CHARACTERISTIC	
SIF Reply Code train output (up to 12 information pulses, plus two framing pulses and optional "X" pulse)	Polarity	Positive
	Amplitude	a. VARI OUT, LO - 0 to approx. 5 volts b. VARI OUT, HI - 7 to approx. 30 volts c. MOD DRIVE, LO - approx. 25 volts d. MOD DRIVE, HI - approx. 45 volts
	Rise Time	a. VARI OUT, .05 μsec or less b. MOD DRIVE, 0.1 μsec or less
	Decay Time	a. VARI OUT, 0.1 μsec or less b. MOD DRIVE, LO - 0.15 μsec or less c. MOD DRIVE, HI - 0.2 μsec or less
	Pulse Width	0.3 to 1.0 microsecond (nominal 0.45 μsec)
	Pulse Spacing	1.45 microseconds (±.05%)
	Residual Delay	4 microseconds or less from application of input trigger
Oscilloscope	Vertical Sensitivity	Calibrated settings at 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, and 20.0 volts per inch
	Vertical Rise Time	Less than 0.05 μsec
	Horizontal Sweep Speed	Variable from 1 to 20,000 μsec per sweep
	Horizontal Sweep Delay	0 to 750 microseconds
	Frequency Response	Essentially flat (±1.5 db) from 50 Hz to 6 mHz
Variable Delay Trigger Pulse Output	Polarity	Positive
	Width	0.5 to 3 microseconds
	Amplitude	a. 50 to 100 volts into 500 ohm load bypassed by 175 pf capacitor b. 20 volts into 75 ohms load bypassed by 1100 pf capacitor
	Rise Time	0.2 μsec, 10% to 90% level
	Decay Time	1 μsec, 90% to 10% level
	Prf	15 to 5100 pps or 7.5 to 2050 pps depending upon SYNC SELECT position
	Delay	0 (within 0.25 μsec) to 750 microseconds

Table 1-2. Radar Test Set TS-1253A/UP Quick Reference Data (Cont.)

FUNCTION	CHARACTERISTIC	
Zero ("0") Delay Trigger Output	Polarity	Positive
	Width	Not less than 0.5 μsec
	Amplitude	a. 50 to 100 volts into 500 ohm load bypassed by 175 pf capacitor
		b. 20 volts into 75 ohm load bypassed by 1100 pf capacitor
	Prf	15 to 4100 pps
	Delay	Zero (fixed)
Intensity Marker Output	Type	Intensity modulation marking of oscilloscope trace
	Spacing	0.1, 0.1 and 1.0, 1.0, 5.0 (±0.25%) and 50.0 microseconds (±0.5%)
	Marker Width	Less than 0.02 microseconds for 0.1, less than .05 μsec for 1.0, less than 0.1 μsec for 5.0 and less than 1.0 for 50 microsecond spacing
Substitute Pulse Output	Polarity Amplitude Width Residual Delay	Same as for SIF coded replies
	Position	Any selected pulse in the reply pulse train except the first framing pulse (and ID pulse). The substitute pulse is variable within ±1.6 microseconds of the position of the omitted pulse
Crystal Marker Output	Type	Positive and negative display on time-sharing basis with video
	Spacing	1.0 or 1.45 microseconds (±0.05%).
	Amplitude	Variable to one inch on display, independent of vertical attenuation
	Marker Width	Less than 0.02 microsecond
Suppressor Pulse Output	Polarity	Positive
	Width	2 to 220 microseconds, adjustable
	Rise Time	10% to 10 volt level, 0.4 μsec max.
	Decay Time	10 volt level to 10%, 0.4 μsec max.
	Amplitude	a. 20 volts into 500 ohm load bypassed by 175 pf capacitor
		b. Not less than 3 volts into 75 ohm load bypassed by 1100 pf capacitor
	Prf	15 to 4100 pps
Identification of Position Pulse (ID)	Pulse Characteristics	Same as above SIF code. A single pulse is added, spaced 24.65 ±0.1 μsec from first bracket pulse of pulse train

Table 1-2. Radar Test Set TS-1253A/UP Quick Reference Data (Cont.)

FUNCTION	CHARACTERISTIC	
Emergency Code	Pulse Characteristics	Same as above. One pair of bracket pulses containing code pulses (7700 for 3/A) followed by 3 pairs of bracket-type pulses, with no code pulses between
Emergency + X	Pulse Characteristics	Same as emergency with center X pulse added to code pulses
Interleaved SIF code trains, (Same as above SIF Reply Code trains, but a second train which is a delayed copy of the first is superimposed.)	Pulse Characteristics Delay	Same as above Second pulse train may be varied continuously from 0.1 to 2.3 μsec with respect to the first train

Table 1-3. Coder Simulator SM-197A/UPM-98 Quick Reference Data

FUNCTION	CHARACTERISTIC	
IFF Interrogation Pulse Pairs	Polarity	Positive or negative
	Amplitude (maximum control setting)	35 volts minimum into 75 ohms resistive load
	Pulse Spacing (P1 to P3)	Mode 1 3 ±0.05 μsec Mode 2 5 ±0.05 μsec Mode 3/A 8 ±0.05 μsec Mode C 21 ±0.05 μsec
	Pulse Width	0.3 to 1.3 μsec (nominal 0.8)
	Pulse Rise Time	0.1 μsec maximum
	Pulse Decay Time	0.2 μsec maximum
Calibration Pulses	Duration	2.5 ±0.5 microseconds
	Prf	15 to 4100 pps
	Amplitude	0.1, 0.5, 1, 2, 5, 10 or 50 volts, positive
	Rise Time and Decay Time for each amplitude and with the specified capacitance	

Volts	C_L (pf)	T_R, (μsec)	T_D, (μsec)
0.1	40	.05	0.1
0.5	40	.05	0.1
1	40	.05	0.1
2	40	.05	0.1
5	40	.05	0.1
10	40	0.1	0.2
50	20	0.2	0.5

Table 1-3. Coder Simulator SM-197A/UPM-98 Quick Reference Data (Cont.)

FUNCTION	CHARACTERISTIC	
ISLS (P2) in 3-Pulse System	Pulse Width	0.5 μsec to 1.0 μsec (indexed at 0.8 ±0.05 μsec)
	Amplitude	Adjustable +3 db to -12 db with respect to P1 rf level. Indexed at 0, ±0.5 db and -9 ±1 db
	Spacing	Indexed at 2 ±0.05 μsec
		Mode 1: variable 1.75 to 2.25 μsec
		Modes 2, 3/A, C: variable 1.6 to 2.4 μsec
Note: In 2-pulse system, ISLS pulse is substituted for P3	Rise Time	0.1 μsec maximum
	Decay Time	0.2 μsec maximum
Substitution Pulse	Selected by Sub Pulse Selector, varied in placement by SUB PULSE position control	Variable position pulse. Can replace Pulse P2 (ISLS pulse) or P3 in standard mode interrogations; can replace second, third, or fourth synchronizing pulse or 8 μsec ISLS pulse in mode 4 interrogations.
		Also, can replace second or third reset pulse
		To replace ISLS pulse in P3 position (2-pulse ISLS), the P3 substitute pulse is used
Pulse Modulated RF Signal	Frequency Range	925 to 1225 mHz, continuously tunable
	Power	21 to 121 db below one volt, continuously variable
	Standing Wave Ratio	Less than 2 db into a 53.5 ohm line
	Residual Delay	Not more than 0.3 microseconds
Wavemeter	Frequency Range	925 to 1225 mHz
	Accuracy	±0.7 mHz (±0.2 mHz at 1030 mHz)
Pulse Counter	Ranges	a. 0 to 500 pps
		b. 0 to 5000 pps
	Accuracy	±10% at full scale, ±30% at one-tenth scale
Demodulator	Frequency Range	925 to 1225 mHz
	Input Impedance	53.5 ohms
	RF Input Capability	LP IN connector: pulsed rf- 0 to 35 peak. Continuous rf average: 0.5 w
		HP IN connector: pulsed rf- 35 to 3500 w peak. Continuous rf average:5 w
		SG IN connector: input from signal generator
	Demodulated Output	0.5 to 3500 w within
	Accuracy	±1 db
Input Power	Voltage	Single Phase ac 115 v ±10%
	Frequency	45 to 420 cps

Table 1-4. Radar Test Set AN/UPM-98A Shipping Data

NAME	DESIGNATION	HEIGHT (in.)	WIDTH (in.)	DEPTH (in.)	WEIGHT (lbs)
Radar Test Set, including items below:	AN/UPM-98A	27-1/8	28-1/2	24	248
Radar Test Set	TS-1253A/UP				
Coder Simulator	SM-197A/UPM-98				
Electrical Equipment Case	CY-2726A/UPM-98				
Accessories Case	CY-2725/UPM-98				
Technical Manual					

Table 1-5. Comparison with Similar Equipment

CAPABILITY	AN/UPM-98	AN/UPM-135	AN/UPM-98A
SIF prf 15 to 4100 pps	Yes	Yes	Yes
Mode 4 prf 7.5 to 2050 pps	No	Yes	Yes
Emergency Pulse Train:	No	No	Yes
One set of brackets with code pulses followed by three pairs of bracket pulses	(4 repeated code trains; A and B pulses only)	(4 repeated code trains; A and B pulses only)	
Interleaved SIF Trains	No	No	Yes
Interrogation Mode 1	Yes	Yes	Yes
Interrogation Mode 2	Yes	Yes	Yes
Interrogation Mode 3/A	Yes	Yes	Yes
Interrogation Mode B	No	Yes	No
Interrogation Mode C	No	Yes	Yes
Interrogation Mode D	No	Yes	No
Interrogation Mode 4 (Sync Pulses)	No	No	Yes
ISLS	No	No	Yes
Mode 4 Decode (3-Pulse Reply)	No	No	Yes
Mode Identification Tags	No	Yes	Yes
Reset Pulses	No	No	Yes
1030 $\pm$0.2 mHz Signal Generator Calibrator	No	Yes	Yes
SGL Reply Pulses	Yes	Yes	No
DBL Reply Pulses	Yes	Yes	No
EMER Reply Pulses	Yes	Yes	No
Interrogation Pulse Substitution	Yes	Yes	Yes
ISLS Pulse Substitution	No	Yes	Yes
Reset Pulse Substitution	No	No	Yes

Table 1-6. Identification of Assemblies and Subassemblies

REF DESIG NO.	NAME	REF DESIG NO.	NAME
1	Display Unit	8A9	Directional Coupler Assembly
2	Sweep and Intensity Mark Unit	9	Calibration-Control Unit
3	Crystal Mark and Sync Unit	9A2	ALC Input Integrator Subassembly
4	SIF Coder	9A4	Mode 4 Reply Decoder
4A1	Code Delay Line Subassembly	10	Not Used
4A2	Interleaved Code Train Generator Assembly	11	External Cables Accessories
5	TS-1253A/UP Panel-Chassis Assembly	12	Interrogation Coder
6	Not Used	12A1	Clock and Line Drive Assembly
7	Electrical Equipment Case	12A2	Code Delay Line Assembly
8	SM-197A Panel-Chassis Assembly	12A3	Diode Matrix Assembly
8A1	RF Oscillator Assembly	12A4	Blocking Oscillator Assembly
8A2	ALC/Attenuator Assembly	12A5	RF (ISLS) Subassembly
8A3	Wavemeter Assembly	12A6	Delay and Tag Generator Assembly
8A4	Demodulator Assembly		

Table 1-7. Test Equipment Required For Troubleshooting and Maintenance

NO.	TEST EQUIPMENT	DESIGNATION	ALTERNATE	APPLICATION
1	Multimeter	AN/PSM-4	Simpson 303	Voltage measurements
2	Oscilloscope	AN/USM-105A	Tektronix 545A or 535A	Waveform display
3	RF Power Meter	AN/USM-177	Hewlett-Packard 430C	RF attenuator check
4	Square Wave Generator	SG-299C/U	Hewlett-Packard 211C	Video attenuator alignment
5	Pulse Generator	AN/UPM-55	Hewlett-Packard 212A	External Triggering
6	RF Signal Generator	AN/UPM-41A	Hewlett-Packard 612A or 614	Wavemeter Calibration
7	Frequency Counter	AN/USM-207	Hewlett-Packard 524B	Prf adjustment
8	Transfer Oscillator	Hewlett-Packard 540A		Prf adjustment
9	Electronic Multimeter with HV Probe	AN/USM-116	TS-294/C, or RCA voltohmyst	Voltage measurement
10	Standing Wave Indicator	AN/USM-37C		ALC Tests
11	Directional Coupler	Hewlett-Packard 766D		Wavemeter Calibration
12	Slotted Line	IM-193/U	Hewlett-Packard 805A	ALC Tests
13	Thermistor Mount	Hewlett-Packard 477B		Demodulator Calibration

SECTION 2

INSTALLATION

2-1. UNPACKING AND HANDLING.

No special instructions are required for uncrating and unpacking the equipment. However, because Radar Test Set AN/UPM-98A is a precision instrument, rough handling of the equipment must be avoided. If it is dropped or otherwise treated roughly, extensive recalibration may become necessary.

2-2. SITE SELECTION.

No special location is required for operation of Radar Test Set AN/UPM-98A. The placement of the unit is usually temporary and determined by the location of the equipment to be tested.

2-3. POWER REQUIREMENTS AND DISTRIBUTION.

Radar Test Set AN/UPM-98A requires a source of 115 volts ±10%, single phase, 45 to 420 Hz. Power input to the radar test set is through terminals 2 and 3 of terminal board 7TB3 (inside Electrical Equipment Case CY-2726A/UPM-98) to filter 7FL1. From here, power is distributed to blower 7B1, blower motor phase shift capacitors 7C1 and 7C2, lower drawer power distribution connector 7P3, and upper drawer distribution connector 7P2. The two panel-chassis assemblies contain their own power switching, fusing, and dc power supplies. Refer to figure 5-67 for the primary power distribution diagram.

2-4. INSTALLATION LAYOUT.

No installation layout instructions are required for Radar Test Set AN/UPM-98A when used in a temporary location near the equipment to be tested.

When a permanent installation for the radar test set is required, a space of at least 4 inches must be provided at the rear of the case for efficient operation of the blower. Also, space is required in front of the equipment so that drawers and subassemblies may be removed for testing and adjustment. Provision must be made for sufficient space at the front of the equipment for operating and testing. Figures 2-1 and 2-2 are dimensional drawings provided as aids in planning permanent installations. The accessories case is so designed that it can be bolted to the top of the test set by removing the four machine screws, flat washers, and rubber washers in the top of the test set, positioning the accessory case and mounting by means of the holes in the bottom of the accessories case. It provides a convenient storage facility for all the accessories used with the test set.

2-5. INSTALLATION REQUIREMENTS.

a. GROUNDING. - Because of the filter capacitors connected between the ac supply line and the chassis, there is a small difference of ac potential between the equipment case and a true ground when one side of the ac supply line is also grounded. To prevent the possibility of electric shock when the test unit and ground are touched at the same time, make a connection between the case and ground before applying power to the radar test set.

b. INTERCONNECTION OF UNITS. - The operating ac and dc power for all the units of the Radar Test Set AN/UPM-98A are distributed internally through the multiple-pin receptacles of the various plug-in units.

The delayed triggers from the Crystal Mark and Sync unit are also routed internally to the Calibration Control unit for the pulse counting and calibration pulse generator circuits. The "0" triggers from the Crystal Mark and Sync unit are routed to the Sweep Circuits in the Sweep and Intensity Mark Unit to trigger the Display Sweep. Other signal paths between the various units required for testing are established by means of external cable assemblies supplied as accessories to the Radar Test Set AN/UPM-98A (see table 1-1). These interconnections will vary in accordance with the type of test performed and are described in the applicable procedures in this technical manual.

c. CABLE ASSEMBLIES. - Cables supplied with Radar Test Set AN/UPM-98A are, with the exception of the servicing cables, standard types (covered in publications NAVSHIPS 900.171 and NAVSHIPS 0967-000-0110). The servicing cable assemblies CX-4963/UPM and CX-6092/U are required to operate the plug-in units when withdrawn from the drawer-chassis for adjustment or maintenance. Cable assembly CX-4964/UPM is a special cable for connecting sweep signals between the Display unit and the Sweep and Intensity Mark unit of TS-1253A/UP.

2-6. INSPECTION AND ADJUSTMENTS.

a. GENERAL. - After unpacking and before energizing the equipment for the first time, inspect each unit as follows:

(1) Check mechanical operation of all front panel controls to insure that they operate through all positions without excessive binding.

(2) Verify that the plug-in units and the two panel-chassis assemblies are fully inserted into the electrical equipment case and that the appropriate fasteners are firmly in place.

Table 2-1. Radar Test Set AN/UPM-98A Preliminary Control Settings

CONTROL	POSITION
RADAR TEST SET TS-1253A/UP	
DISPLAY UNIT	
INT	Fully ccw
FOCUS	Center
HOR	Center
VERT	Center
75 Ω	OUT
VOLTS/IN (volts per inch)	20
VIDEO SENS	CAL
SCALE	Fully ccw
ASTIG	Center
SWEEP AND INTENSITY MARK UNIT	
SWEEP SPEED RANGE	1-30
SWEEP SPEED ADJUST	Center
MARKER TRIGGER	NORMAL
INTENSITY MARKS RANGE	OFF
INTENSITY MARKS LEVEL	Fully ccw
CRYSTAL MARK AND SYNC UNIT	
SWEEP DELAY RANGE	0
SWEEP DELAY COARSE	Fully ccw
SWEEP DELAY FINE	Fully ccw
TRIGGER DELAY RANGE	0
TRIGGER DELAY COARSE	Fully ccw
TRIGGER DELAY FINE	Fully ccw
SYNC SELECT	INT
XTAL MARK LEVEL	Fully ccw
PRF	Center
SUP	Fully ccw
SIF CODER	
CODE	0000
FUNCTION	N
SUB PULSE SELECT	OFF
LEVEL	LO
SUB PULSE POS	0
PULSE WIDTH	45
AMPLITUDE	Fully ccw (0)
INTERLEAVE	Fully ccw

CONTROL	POSITION
CODER SIMULATOR SM-197A/UPM-98	
ATTENUATION	Fully ccw
SG FREQUENCY	Fully ccw
WAVEMETER INPUT	DEMOD
WAVEMETER FREQUENCY	Fully ccw
CALIBRATION-CONTROL UNIT	
METER SELECT	CAL
WM SENS	Fully ccw
VIDEO OUT	50
CAL ADJ	Fully ccw
TRIGGER	DEMOD
INTERROGATION CODER	
VIDEO Selector Switch	CODE
Sub Pulse Position Control	0
ISLS LEVEL Control	0
Mode Selector Switch	3/A
Function Selector Switch	MOD-INT
CODE WIDTH Control	Center
CODE LEVEL Control	Fully ccw
TRIG Connector Terminate Switch (75 Ω)	Off
MOD Connector Terminate Switch (75 Ω)	Off
ISLS Connector Terminate Switch (75 Ω)	Off
ISLS Selector Switch	OUT
Substitute Pulse Selector Switch	OUT
ISLS WIDTH Control	Center
VIDEO LEVEL Control	Center

b. ADJUSTMENT FOR LOW OR HIGH INPUT POWER CONDITION. - Radar Test Set AN/UPM-98A is designed to operate from an ac power source of 115 volts +10%. However, if the input power in an installation is consistently above or below the nominal 115 volts by more than 5%, the input power connection to the power transformers 5T1 and 8T1, located at the rear of each drawer chassis, should be changed from the 115 volt tap (terminal 3) to the 103.5 volt tap (terminal 2) or to the 126.5 volt tap (terminal 4) accordingly.

2-7. INTERFERENCE REDUCTION.

Radar Test Set AN/UPM-98A has been designed to comply with NAVSHIPS requirements concerning maximum permissible radiation for nonportable equipment. The power source must be free of noise injected by other equipment. Radar Test Set AN/UPM-98A has been designed for a minimum of interference with other equipment and is capable of operating in proximity to high power radar equipment. To ensure proper interference-free operation, all connections to the test set must be completed and assemblies must be properly secured. Make sure equipment is properly grounded. No further interference precautions are required during installation or operation.

2-8. OPERATIONAL CHECKOUT OF EQUIPMENT.

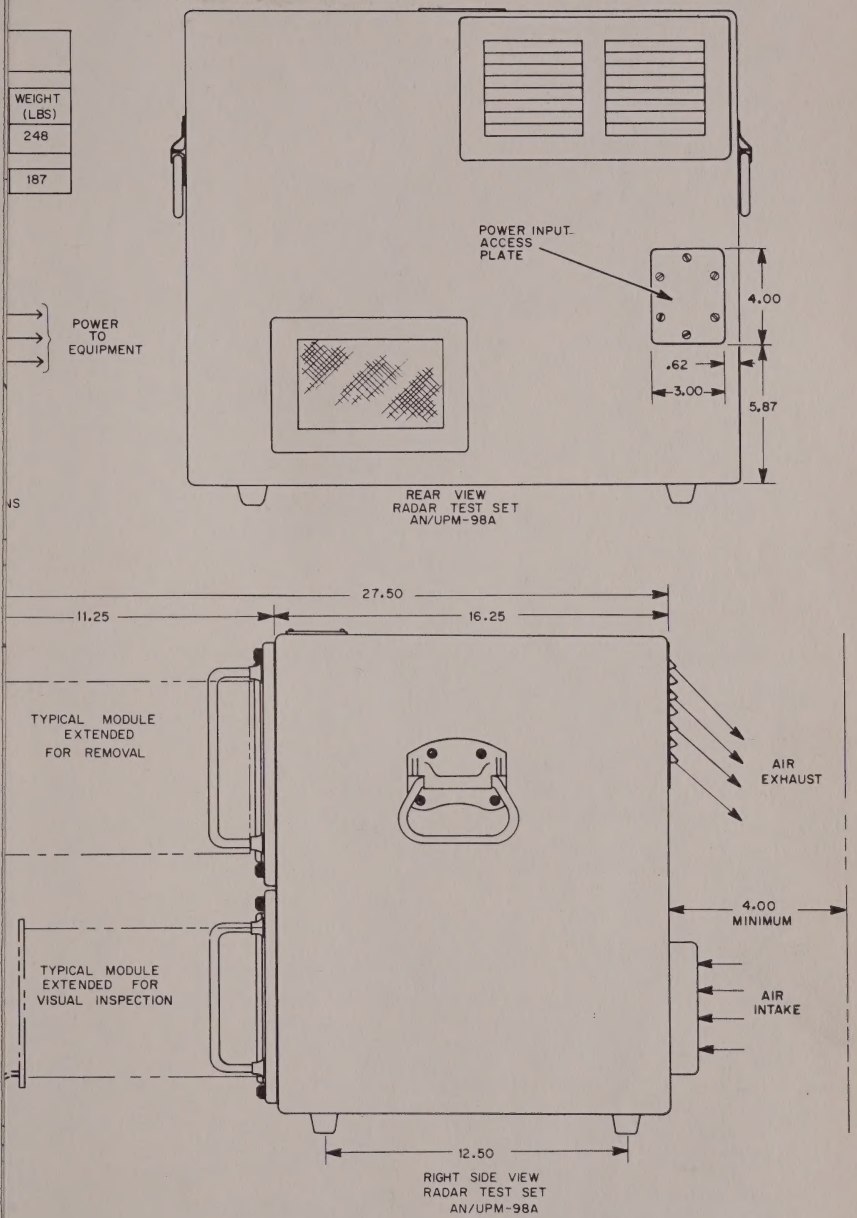


Figure 2-1. Radar Test Set AN/UPM-98A Outline Drawing

Table 2-1. Radar Test Set AN/UPM-98A Preliminary Control Settings

CONTROL	POSITION
RADAR TEST SET TS-1253A/UP	
DISPLAY UNIT	
INT	Fully ccw
FOCUS	Center
HOR	Center
VERT	Center
75 Ω	OUT
VOLTS/IN (volts per inch)	20
VIDEO SENS	CAL
SCALE	Fully ccw
ASTIG	Center
SWEEP AND INTENSITY MARK UNIT	
SWEEP SPEED RANGE	1-30
SWEEP SPEED ADJUST	Center
MARKER TRIGGER	NORMAL
INTENSITY MARKS RANGE	OFF
INTENSITY MARKS LEVEL	Fully ccw
CRYSTAL MARK AND SYNC UNIT	
SWEEP DELAY RANGE	0
SWEEP DELAY COARSE	Fully ccw
SWEEP DELAY FINE	Fully ccw
TRIGGER DELAY RANGE	0
TRIGGER DELAY COARSE	Fully ccw
TRIGGER DELAY FINE	Fully ccw
SYNC SELECT	INT
XTAL MARK LEVEL	Fully ccw
PRF	Center
SUP	Fully ccw
SIF CODER	
CODE	0000
FUNCTION	N
SUB PULSE SELECT	OFF
LEVEL	LO
SUB PULSE POS	0
PULSE WIDTH	45
AMPLITUDE	Fully ccw (0)
INTERLEAVE	Fully ccw

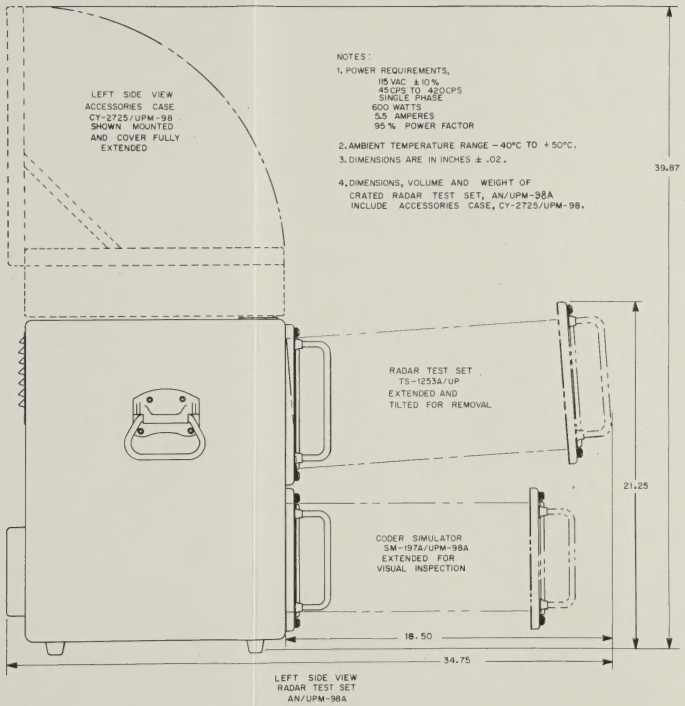
CONTROL	POSITION
CODER SIMULATOR SM-197A/UPM-98	
ATTENUATION	Fully ccw
SG FREQUENCY	Fully ccw
WAVEMETER INPUT	DEMOD
WAVEMETER FREQUENCY	Fully ccw
CALIBRATION-CONTROL UNIT	
METER SELECT	CAL
WM SENS	Fully ccw
VIDEO OUT	50
CAL ADJ	Fully ccw
TRIGGER	DEMOD
INTERROGATION CODER	
VIDEO Selector Switch	CODE
Sub Pulse Position Control	0
ISLS LEVEL Control	0
Mode Selector Switch	3/A
Function Selector Switch	MOD-INT
CODE WIDTH Control	Center
CODE LEVEL Control	Fully ccw
TRIG Connector Terminate Switch (75 Ω)	Off
MOD Connector Terminate Switch (75 Ω)	Off
ISLS Connector Terminate Switch (75 Ω)	Off
ISLS Selector Switch	OUT
Substitute Pulse Selector Switch	OUT
ISLS WIDTH Control	Center
VIDEO LEVEL Control	Center

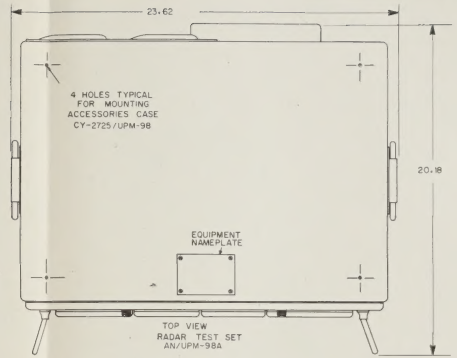
b. ADJUSTMENT FOR LOW OR HIGH INPUT POWER CONDITION. - Radar Test Set AN/UPM-98A is designed to operate from an ac power source of 115 volts ±10%. However, if the input power in an installation is consistently above or below the nominal 115 volts by more than 5%, the input power connection to the power transformers 5T1 and 8T1, located at the rear of each drawer chassis, should be changed from the 115 volt tap (terminal 3) to the 103.5 volt tap (terminal 2) or to the 126.5 volt tap (terminal 4) accordingly.

2-7. INTERFERENCE REDUCTION.

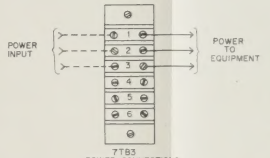
Radar Test Set AN/UPM-98A has been designed to comply with NAVSHIPS requirements concerning maximum permissible radiation for nonportable equipment. The power source must be free of noise injected by other equipment. Radar Test Set AN/UPM-98A has been designed for a minimum of interference with other equipment and is capable of operating in proximity to high power radar equipment. To ensure proper interference-free operation, all connections to the test set must be completed and assemblies must be properly secured. Make sure equipment is properly grounded. No further interference precautions are required during installation or operation.

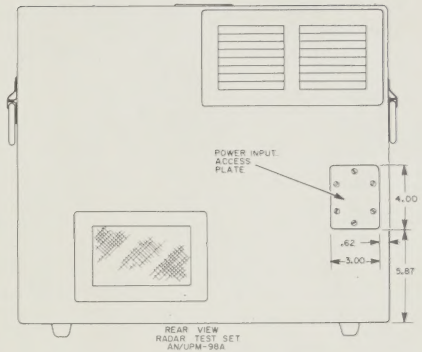
2-8. OPERATIONAL CHECKOUT OF EQUIPMENT.

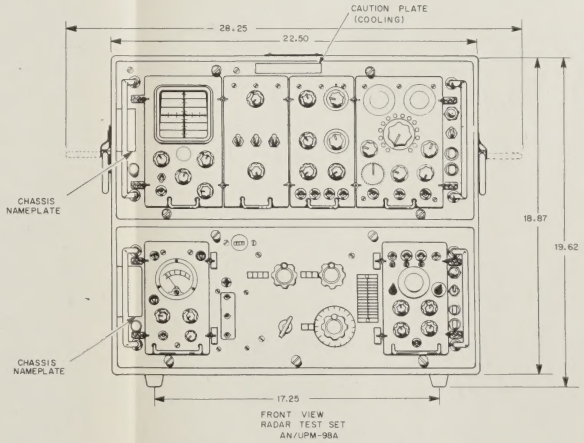




SHIPPING DATA RADAR TEST SET AN/UPM-98A				
CRATED (SEE NOTE 4)				
OVERALL DIMENSIONS			VOLUME	WEIGHT
HEIGHT	WIDTH	DEPTH	(CU. FT.)	(LBS)
27.12	28.50	24.00	11	248
UNCRATED				
19.62	23.62	20.18	6.6	187







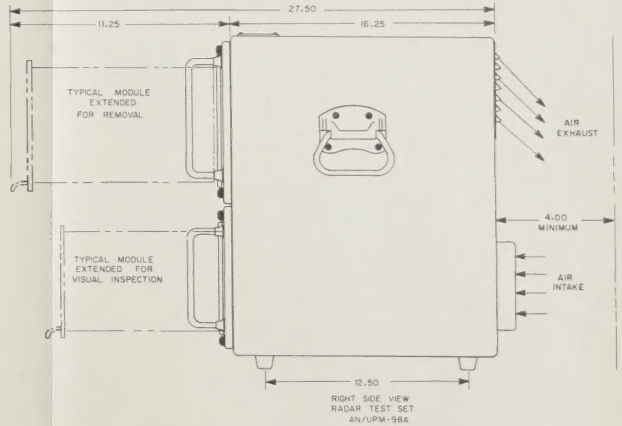
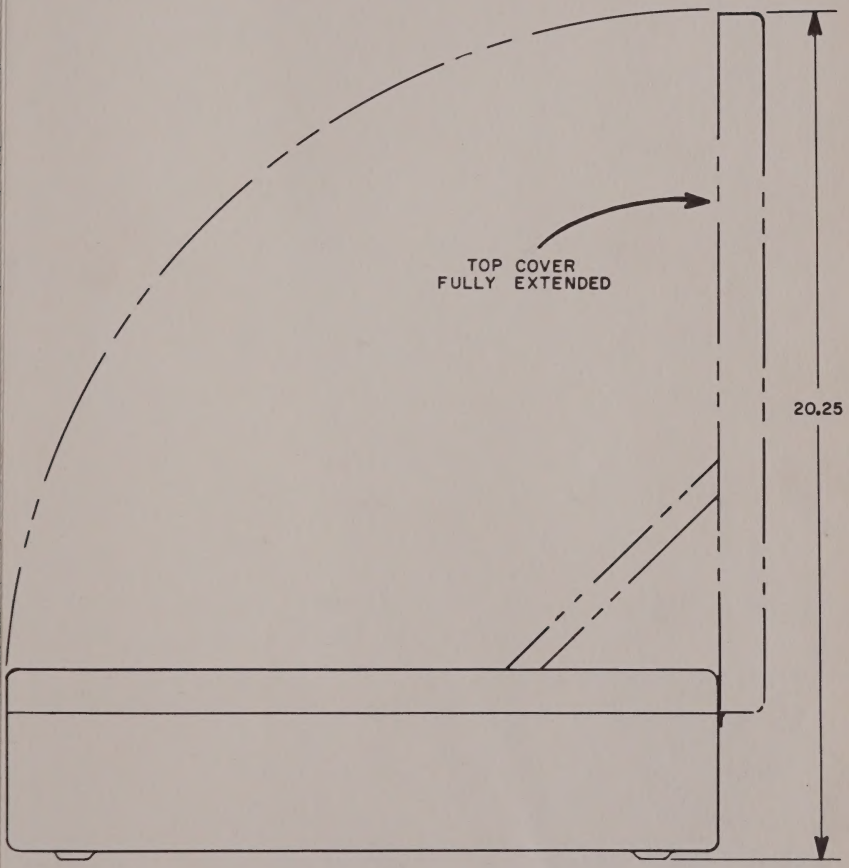


Figure 2-1. Radar Test Set AN/UPM-98A Outline Drawing

NS ARE IN INCHES ± .02.

CCESSORIES CY-2725/UPM-98				
UNCRATED				
L DIMENSIONS			VOLUME (CU. FT)	WEIGHT (LBS)
	WIDTH	DEPTH		
	22.50	16.87	1.0	37



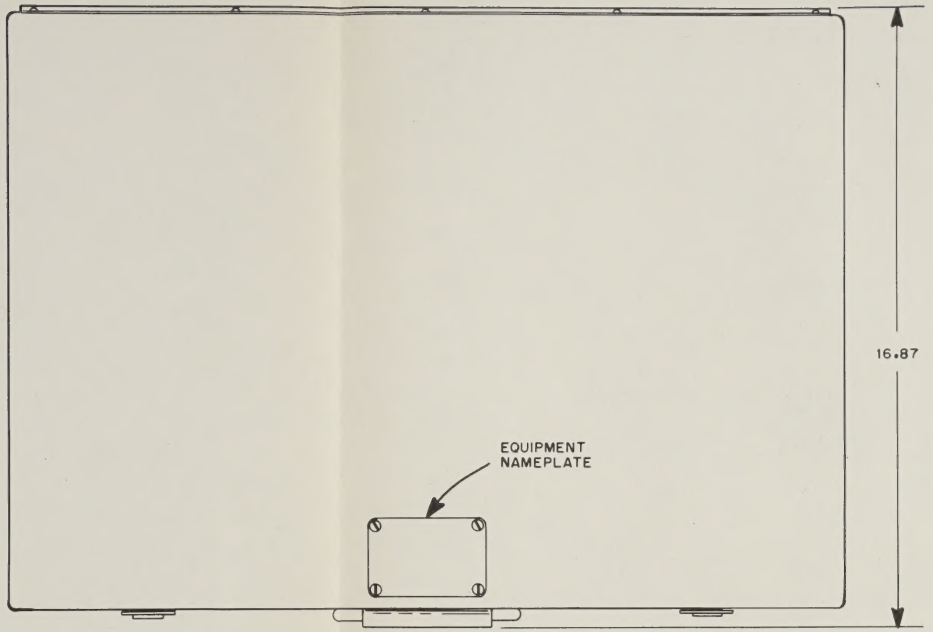
RIGHT SIDE VIEW
CASE, ACCESSORIES
CY-2725/UPM-98

Figure 2-2. Accessories Case CY-2725/UPM-98 Outline Drawing

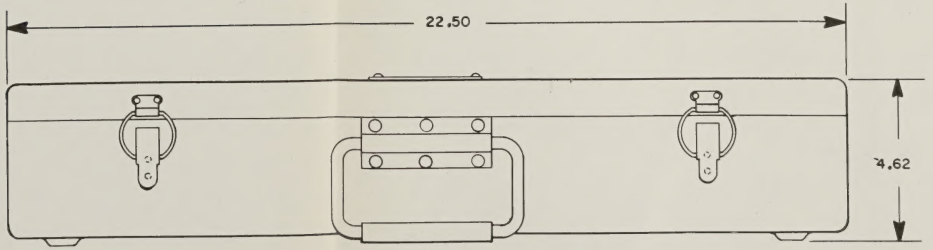
NOTE:

1. DIMENSIONS ARE IN INCHES ± .02.

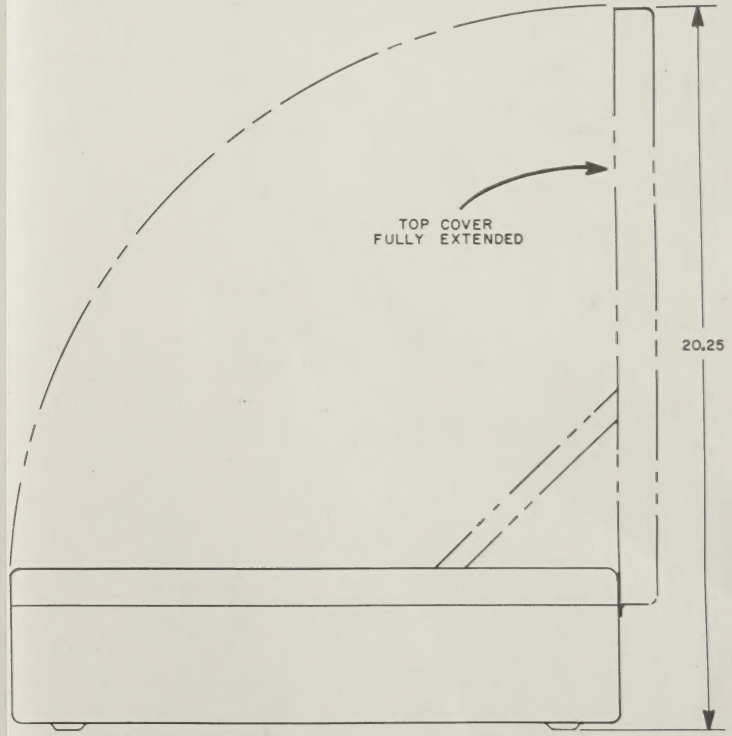
CASE, ACCESSORIES CY-2725/UPM-98				
UNCRATED				
OVERALL DIMENSIONS			VOLUME (CU. FT)	WEIGHT (LBS)
HEIGHT	WIDTH	DEPTH		
4.62	22.50	16.87	1.0	37



TOP VIEW
CASE, ACCESSORIES
CY-2725/UPM-98



FRONT VIEW
CASE, ACCESSORIES
CY-2725/UPM-98



RIGHT SIDE VIEW
CASE, ACCESSORIES
CY-2725/UPM-98

Figure 2-2. Accessories Case CY-2725/UPM-98 Outline Drawing

a. GENERAL. - Before using the test set for the first time after unpacking, or at any time when there is a need to check that the test set is in full operational readiness, use the procedure given below. If any normal indication cannot be obtained, refer to the troubleshooting and maintenance procedures in sections 4 and 5.

b. CHECKOUT OF RADAR TEST SET TS-1253A/UP. - Place all operating controls (figure 3-1) in preliminary settings given in table 2-1, then proceed as follows:

(1) DISPLAY AND ASSOCIATED UNITS

Step 1. Turn POWER switch on TS-1253A/UP to ON position.
Step 2. Allow fifteen minutes warmup.
Step 3. Advance INTEN control on Display unit until trace is visible on CRT.

NOTE

It may be necessary to advance PRF control to increase display intensity.

Step 4. Adjust VERT and HOR controls on Display unit to move the trace to the center of CRT screen.
Step 5. Adjust FOCUS and ASTIG controls on Display unit for sharp, even trace.
Step 6. Set SYNC SELECT switch on Crystal Mark and Sync unit to INT 1.00. Advance XTAL MARK LEVEL control until pulse appears on trace.
Step 7. Turn XTAL MARK LEVEL control on Crystal Mark and Sync unit fully counterclockwise to eliminate crystal marks.
Step 8. Connect CG-530B/U cable from 0 TRIGGERS connector on Crystal Mark and Sync unit to VIDEO input connector on Display unit. The trailing edge of the trigger pulse should appear on the display.
Step 9. Set VOLTS/IN switch and adjust VIDEO SENS control on Display unit for two-inch pulse height on display.
Step 10. Set INTENSITY MARKS RANGE switch on Sweep and Intensity Mark unit to .1 position.
Step 11. Advance INTENSITY MARKS LEVEL control on Sweep and Intensity Mark unit until intensity marks are visible on sweep trace. Nine to thirteen intensity marks should be visible on the full trace.
Step 12. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit fully clockwise. Set Intensity Marks Range switch to 1.0 position. At least thirty 1-μsec intensity marks should be visible on the full trace.
Step 13. Set INTENSITY MARKS RANGE switch on Sweep and Intensity Mark unit to 5.
Step 14. Set SWEEP SPEED RANGE switch on Sweep and Intensity Mark unit to 20-200. At least four 5-μsec markers should be visible with SWEEP SPEED ADJUST control fully counterclockwise.
Step 15. Remove coaxial cable from 0 TRIGGERS connector and connect to SUP TRIGGERS connector on Crystal Mark and Sync unit. Turn SWEEP SPEED ADJUST control fully clockwise. One suppressor pulse should be visible at left end of trace.
Step 16. Turn SUP control on Crystal Mark and Sync unit clockwise and observe pulse width. Pulse width should be at least 220 microseconds.
Step 17. Turn SUP control on Crystal Mark and Sync unit fully counterclockwise.
Step 18. Disconnect coaxial cable from SUP TRIGGER connector on Crystal Mark and Sync unit and connect to DELAYED TRIGGER connector on Crystal Mark and Sync unit.
Step 19. Set INTENSITY MARKS RANGE switch on Sweep and Intensity Mark unit to 50. At least four 50-μsec marks should be visible on full trace with SWEEP SPEED control fully clockwise.
Step 20. Adjust VOLTS/IN (volts per inch) switch and VIDEO SENS (sensitivity) control on Display unit for two-inch display of delayed trigger pulse at left end of trace.
Step 21. Set TRIGGER DELAY RANGE switch on Crystal Mark and Sync unit to 1-11 and set SWEEP SPEED ADJUST on Sweep and Intensity Mark unit fully counterclockwise.
Step 22. Turn TRIGGER DELAY FINE control on Crystal Mark and Sync unit clockwise and note that delayed trigger pulse moves from its extreme left position on trace toward the center.
Step 23. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 1-11.
Step 24. Turn SWEEP DELAY FINE

control on Crystal Mark and Sync unit clockwise. The delayed trigger pulse should move back to left end of trace.

Step 25. Disconnect cable from VIDEO connector on Display unit.

Step 26. Press TRIGGER DELAY STROBE switch on Sweep and Intensity Mark unit. The delayed trigger pulse should appear slightly to the left of center on trace.

Step 27. Release TRIGGER DELAY STROBE switch. Press down SWEEP DELAY STROBE switch on Sweep and Intensity Mark unit. The delayed sweep pulse should appear slightly to the left of center on trace. Release SWEEP DELAY STROBE switch.

Step 28. Connect coaxial cable to VIDEO connector on Display unit.

Step 29. Turn SWEEP DELAY FINE control on Crystal Mark and Sync unit fully counterclockwise.

Step 30. Set TRIGGER DELAY RANGE switch on Crystal Mark and Sync unit to 5-50. The delayed trigger pulse should appear approximately at the center of trace.

Step 31. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 11-21. The delayed trigger pulse should appear near left end of trace.

Step 32. Turn TRIGGER DELAY COARSE control on Crystal Mark and Sync unit clockwise until pulse moves to right end of trace.

Step 33. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 21-31. The delayed trigger pulse should appear slightly to the right of center on the trace.

Step 34. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 5-50.

Step 35. Turn SWEEP DELAY FINE control on Crystal Mark and Sync unit fully clockwise. The delayed trigger pulse should appear at the right end of the trace.

Step 36. Set TRIGGER DELAY RANGE switch on Crystal Mark and Sync unit to 50-750.

Step 37. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 50-750.

Step 38. Turn SWEEP DELAY COARSE control on Crystal Mark and Sync unit clockwise until the delayed trigger pulse appears at right end of trace. Five-microsecond intensity marks should appear to move left during clockwise rotation of SWEEP DELAY COARSE control.

Step 39. Set MARKER TRIGGER switch on Sweep and Intensity Mark unit to SWEEP.

Step 40. Rotate SWEEP DELAY COARSE control on Crystal Mark and Sync unit through entire range and back to original setting. The intensity marks should appear stationary during this control adjustment.

Step 41. On Sweep and Intensity Mark unit, set MARKER TRIGGER switch to NORMAL.

Step 42. Set TRIGGER DELAY RANGE switch on Crystal Mark and Sync unit to 1-11.

Step 43. Set SWEEP DELAY RANGE switch on Crystal Mark and Sync unit to 0.

Step 44. Disconnect coaxial cable from VIDEO connector on Display unit and reconnect to TRIGGER INPUT connector on SIF Coder.

(2) SIF CODER

(a) GENERAL

Step 1. Connect coaxial cable from MOD DRIVE connector on SIF Coder to VIDEO connector on Display unit.

Step 2. Set all four CODE selectors on SIF Coder to 7.

Step 3. Set FUNCTION selector on SIF Coder to ID.

Step 4. Adjust VOLTS/IN switch and VIDEO SENS control on Display unit for two-inch pattern height.

Step 5. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit clockwise until a train of fifteen pulses is seen. These shall appear as a group of fourteen code pulses with a blank space at the center, followed by a single separate ID pulse.

Step 6. Set FUNCTION selector on SIF Coder to X. The pulse train should now contain fifteen evenly spaced pulses. (The separate ID pulse is removed and the center space is now occupied by an X pulse).

(b) SIF SUBSTITUTE PULSES

Step 1. Turn SUB PULSE SELECT switch on SIF Coder one

position clockwise (from OFF to C1 position).

Step 2. Turn SUB PULSE POS control on SIF Coder in both directions. The second pulse in the train (C1) should be movable from left to right on either side of the normal pulse position. The substitute pulse should be in the normal position when SUB PULSE POS control is set to 0.

Step 3. To check position adjustment of each of the remaining thirteen pulses, repeat steps 1 and 2 above with the SUB PULSE SELECT switch moved to the next position for each succeeding pulse.

Step 4. Set SUB PULSE SELECT switch on SIF Coder to OFF.

Step 5. Turn PULSE WIDTH control on SIF Coder in both directions. Note change in width of pulses. Return control to .45 position.

(c) EMERGENCY AND X PULSES

Step 1. Set FUNCTION Selector on SIF Coder to EMER + X.

Step 2. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit clockwise until a series of four pulse trains is seen on trace. The first train should consist of two bracket pulses and any selected information pulses, with the X pulse in the center. The remaining three trains should consist of only two pulses each (resembling bracket pulse pairs).

Step 3. Set FUNCTION selector on SIF Coder to EMER. The center (X) pulse in the first train should disappear

(d) OUTPUT LEVEL

Step 1. Set LEVEL switch on SIF Coder to HI. Oscilloscope pattern height should increase by approximately 30 percent.

Step 2. Disconnect cable from MOD DRIVE connector and connect it to VARI OUTPUT connector on SIF Coder.

Step 3. Turn AMPLITUDE control on SIF Coder fully clockwise.

Step 4. Adjust VOLTS/IN switch and VIDEO SENS control on Display unit for a one-inch pattern height.

Step 5. Turn AMPLITUDE control on SIF Coder fully counterclockwise. The pattern height should decrease to zero. Return to one-inch setting.

(e) INTERLEAVED SIF TRAINS

Step 1. Set FUNCTION selector on SIF Coder to I position. A normal code train and an identical but delayed train which is interleaved with the normal train should be seen.

NOTE

SUB PULSE SELECT switch should be in OFF position. If it is not, the pulse selected will be omitted from both the normal and the delayed train.

Step 2. Check that the delayed train is variable in position by means of the INTERLEAVE control. The control does not permit adjustment to zero delay; however, the delay may be increased until each interleaved pulse merges with and overlaps the next pulse in the normal train.

Step 3. Return FUNCTION selector to N position.

Step 4. Disconnect cables from front panel connectors.

c. CHECKOUT OF CODER SIMULATOR SM-197A/UPM-98. - Place all operating controls (figure 3-4) in the preliminary positions given in table 2-1. The coder simulator is checked out in conjunction with the Radar Test Set TS-1253A/UP; therefore, before starting any checks on the SM-197A, ascertain that the TS-1253A/UP is functional, then proceed with the following steps:

(1) PREPARATION

Step 1. Connect coaxial cable between VIDEO input connector on Display unit and VIDEO OUT connector on Calibration-Control unit. Place SM-197A POWER switch in ON position.

Step 2. Advance INT control on Display unit until trace is visible.

Step 3. Adjust VERT and HOR controls on Display unit to center trace.

Step 4. Adjust FOCUS and ASTIG controls on Display unit for sharp, even trace.

Step 5. Set VOLTS/IN switch on Display unit to.1.

Step 6. Set TRIGGER DELAY RANGE switch on Crystal Mark and Sync unit to 1-11.

Step 7. Set SWEEP SPEED RANGE switch on Sweep and Intensity Mark unit to 1-30.

(2) CALIBRATION-CONTROL UNIT.

(a) GENERAL.

Step 1. Set VIDEO OUT switch on Calibration-Control unit to .1.

Step 2. Set TRIGGER switch on Calibration-Control unit to INT.

Step 3. With METER SELECT switch in CAL position, turn CAL ADJ control on Calibration-Control unit clockwise until Calibration-Control meter indication is full scale.

Step 4. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit clockwise until a complete calibration pulse can be seen on the oscilloscope trace. (Pulse height should be 1 +.05 inches.)

Step 5. Set VIDEO OUT switch to .5, 1, 2, 5, and 10 successively. In each position, set VOLTS/IN switch on Display unit to corresponding value and repeat steps 3 and 4.

Step 6. Set VIDEO OUT switch to 50. Set VOLTS/IN switch to 20. Repeat step 3. Pulse height should be 2.5 +0.125 inches.

Step 7. Set METER SELECT switch on Calibration-Control unit to 500 PRF.

Step 8. Turn PRF control on Crystal Mark and Sync unit until reading of 500 (full scale) is obtained on Calibration-Control meter.

Step 9. Set METER SELECT switch on Calibration-Control unit to 5000 PRF. The Calibration-Control meter should indicate 50. Read as 500 by multiplying by 10.

Step 10. Set METER SELECT switch on Calibration-Control unit to WM.

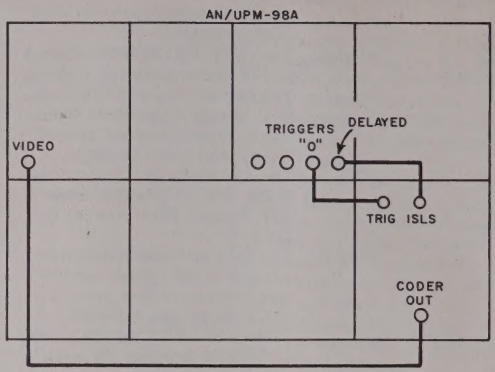
Step 11. Set VIDEO OUT switch on Calibration-Control unit to SG MON.

Step 12. Disconnect cable from VIDEO OUT connector on Calibration-Control unit and VIDEO connector on Display unit.

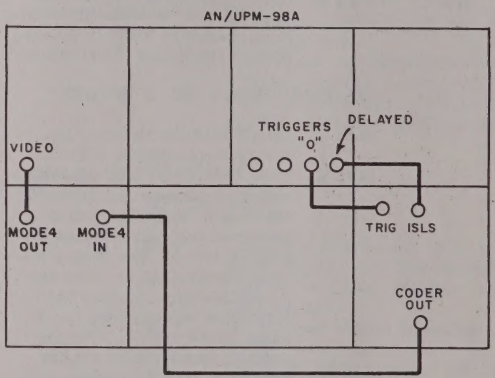
(b) MODE 4 REPLY DECODING.

Step 1. Connect equipment as in figure 2-3A to provide a source of simulated Mode 4, 3-pulse reply signals.

Step 2. Set INTENSITY MARKS RANGE on Sweep and Intensity Mark unit to 1 position and adjust INTENSITY MARKS LEVEL until markers are visible.



A. Checking Input Pulse Spacing



B. Checking Single Pulse Mode 4 Decode Output

Figure 2-3. Hookup for Mode 4 Reply Decoding Check

Step 3. Set SWEEP RANGE to 1-30 position and vary SWEEP SPEED ADJUST to display seven markers.

Step 4. Set VOLTS/IN on Display unit to 5.

Step 5. On Interrogation Coder set Mode Selector to 1, Function Selector to TEST, Substitute Pulse Selector to P3, ISLS Selector to EXT, and CODE LEVEL and VIDEO LEVEL controls to mid-scale.

Step 6. On Crystal Mark and Sync unit set TRIGGER DELAY RANGE to 5-50, set SWEEP DELAY RANGE to 21-31, and adjust SWEEP DELAY FINE control to display three pulses.

Step 7. On Interrogation Coder, adjust SUB PULSE POS control to place the third pulse 3.6 microseconds from the first pulse (between leading edges). (Note: The second pulse here is provided by the ISLS pulse.)

Step 8. Use the TRIGGER DELAY FINE control to place the second pulse 1.8 μsec behind the leading edge of the first pulse.

Step 9. Adjust the CODE WIDTH and ISLS WIDTH controls on the Interrogation Coder to obtain a 0.45 μsec pulse width.

Step 10. Adjust the CODE LEVEL control to equalize pulse amplitude.

Step 11. Adjust the VIDEO LEVEL control for a 5-volt pulse amplitude.

Step 12. Disconnect cable from VIDEO input on Display unit and connect if to MODE 4 IN connector on Calibration-Control unit (figure 2-3B).

Step 13. Connect a cable between the MODE 4 OUT connector on the Calibration-Control unit and the VIDEO input connector on the Display unit.

Step 14. Check oscilloscope for a single pulse output for each 3-pulse input. The output pulse should have the following characteristics.

Polarity	Positive
Amplitude	5 volt max.
Duration	0.5 $\pm$0.1 μsec
Rise Time	Less than 0.1 μsec
Decay Time	Less than 0.15 μsec

(3) INTERROGATION CODER

(a) GENERAL

Step 1. Connect coaxial cable between DELAYED TRIGGERS connector on Crystal Mark and Sync unit and TRIG connector on Interrogation Coder.

Step 2. Connect coaxial cable between CODER OUT connector on Interrogation Coder and VIDEO input connector on Display unit.

Step 3. Set Mode Selector on Interrogation Coder to the 1 position, Function Selector to (+) position, ISLS Selector to OUT position, VIDEO Selector to CODE, and Substitute Pulse Selector to OUT.

Step 4. Turn VIDEO LEVEL control on Interrogation Coder clockwise until pattern height of one inch is obtained on oscilloscope.

Step 5. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit clockwise until both coder output pulses appear on the oscilloscope trace.

Step 6. Turn CODE WIDTH control on Interrogation Coder clockwise. Note increase in width of both pulses. Reset CODE WIDTH control to center position.

(b) CODE PULSE SPACING

Step 1. Change Mode Selector on Interrogation Coder from the 1 position to the 2 position. Spacing of output pulse pair should increase about 66 percent (from 3 microseconds to 5 microseconds).

Step 2. Set Mode Selector on Interrogation Coder to the 3/A position. Spacing of output pulse pair should increase about 60 percent (from 5 microseconds to 8 microseconds).

Step 3. Set Mode Selector on Interrogation Coder to the C position. Spacing of output pulse pair should increase about 2-1/2 times (from 8 microseconds to 21 microseconds).

Step 4. Set SWEEP SPEED RANGE switch on Sweep and Intensity Mark unit to 20-200.

Step 5. Turn SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit until both coder output pulses appear on trace. Further rotation of the control should not cause additional output pulses to appear beyond the two observed near mid-range control setting.

Step 6. Set Function Selector on Interrogation Coder to (-) position. The polarity of the coder output pulses should appear inverted on oscilloscope trace. Return Function Selector to (+) position.

(c) ISLS PULSE CHECK

Step 1. Set Mode Selector on Interrogation Coder to 3/A. Turn SWEEP SPEED RANGE and ADJUST controls on Sweep and Intensity Mark unit until a pair of code pulses appears on the oscilloscope.

Step 2. Set ISLS Selector on the

Interrogation Coder to the 2 μsec position. Set the Function Selector on the Interrogation Coder to TEST.

Step 3. Rotate ISLS LEVEL control on Interrogation Coder back and forth and check that the ISLS pulse (P2), located one-fourth of the way from the P1 to the P3 pulse, varies in amplitude. Set the ISLS pulse level so that amplitudes of P1 and P2 are equal.

Step 4. Turn ISLS WIDTH control on Interrogation Coder and note that the P2 changes in width. Reset control to center position.

Step 5. Set ISLS Selector on the Interrogation Coder to the 2 PULSE position. The ISLS pulse should replace the P3 pulse. Check by repeating steps 3 and 4 above.

Step 6. Connect an external trigger source (or the delayed trigger) from the Crystal Mark and Sync unit to the ISLS connector on the Interrogation Coder. Set the ISLS Selector to the EXT position. Vary the timing of the external trigger and note that the P2 pulse follows.

Step 7. Set the ISLS Selector to the OUT position. Note that the ISLS pulse disappears.

(d) INTERNAL MODULATION OF INTERROGATION CODER.

Step 1. Disconnect cable from VIDEO connector on Display unit and CODER OUT connector on Interrogation Coder.

Step 2. Connect coaxial cable between VIDEO OUT connector on Cal-Control unit and VIDEO connector on Display unit.

Step 3. Set VOLTS/IN switch on Display unit to .5 position.

Step 4. Set SG FREQUENCY control to approximately 100.

Step 5. On Cal-Control unit, place VIDEO OUT switch in SG MON position.

Step 6. Set the Function Selector on Interrogation Coder to MOD-INT position. Two negative code pulses should appear on oscilloscope trace.

(e) INTERROGATION CODER SUBSTITUTE PULSES

Step 1. Set the Substitute Pulse Selector on the Interrogation Coder to P3. A pulse which can be varied in time should replace the P3 (the last) pulse.

Step 2. Rotate the SUB PULSE POS control on the Interrogation Coder back and forth on both sides of the center position. Note that the substitute pulse is shifted in both directions.

Step 3. Return the Substitute Pulse Selector to the OUT position.

(f) SIF CODER MODULATION OF INTERROGATION CODER

Step 1. Connect coaxial cable between MOD DRIVE connector on SIF Coder and MOD connector on Interrogation Coder.

Step 2. Connect coaxial cable between OUT (40 μsec delayed trigger) connector on Interrogation Coder and TRIGGER INPUT connector on SIF Coder.

Step 3. Connect Display unit VIDEO input to VIDEO OUT connector on Cal-Control unit and set VIDEO OUT selector on Cal-Control unit to SG MON.

Step 4. Set Function selector on Interrogation Coder to MIX position.

Step 5. Set VIDEO selector on Interrogation Coder to RESET position.

Step 6. Set SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit as required to view the three reset tag pulses.

Step 7. Set LEVEL switch on SIF Coder to HI position and CODE selectors to 7777.

Step 8. Set VIDEO selector on Interrogation Coder to BOTH position. Note that the SIF pulse train is followed by the three reset tag pulses and preceded by the two mode identification pulses. Return VIDEO selector to CODE position. Only the mode identification (interrogation) pulses should remain on the display.

(4) WAVEMETER.

Step 1. Turn WM SENS control on Cal-Control unit fully clockwise and METER SELECT switch to WM.

Step 2. Turn WAVEMETER INPUT switch to SIG GEN.

Step 3. Turn WAVEMETER FREQUENCY control until resonance is indicated by a dip of the Cal-Control meter needle.

Step 4. Turn WM SENS control on Cal-Control unit clockwise and "rock" WAVEMETER FREQUENCY control to determine exact point of minimum meter reading (exact wavemeter resonance point).

Step 5. Remove cable from DELAYED TRIGGER connector on Crystal Mark and Sync unit and TRIG connector on Interrogation Coder.

Step 6. Remove all cable from front panel connectors. Return all equipment controls to preliminary settings listed in table 2-1.

SECTION 3

OPERATOR'S SECTION

3-1. FUNCTIONAL OPERATION.

a. GENERAL.- Radar Test Set AN/UPM-98A is designed primarily for use in testing Mark X IFF/SIF equipment. However, it can also be used to make various tests on other radar equipment operating within the 925 to 1225 megahertz frequency range. The set consists primarily of Radar Test Set 1253A/UP and Coder Simulator SM-197A/UPM-98.

b. RADAR TEST SET TS-1253A/UP.- This unit combines the functions of a precision oscilloscope and an SIF code pulse generator. Figure 3-1 is a front view of the TS-1253A/UP unit showing all the operating controls.

(1) OSCILLOSCOPE.- The oscilloscope circuitry is contained in the Display, Sweep and Intensity Mark, and Crystal Mark and Sync plug-in units. The video pulses to be displayed are applied through a coaxial cable or the Test Lead MX-2681/UP (furnished with the equipment) to the VIDEO connector on the Display unit front panel. The video input line can be internally terminated in a 75-ohm impedance by placing the 75Ω switch in the IN position.

The FOCUS and ASTIG controls adjust the sharpness and evenness of the display trace, and the INTEN control adjusts the brightness of the trace. To avoid display "blooming", just enough intensity should be used to afford comfortable viewing. The displayed pattern is centered on the cathode ray tube screen by adjusting the HOR and VERT controls. The vertical size of the display (for a given input voltage) is determined by the VOLTS/IN switch.

The VOLTS/IN switch permits setting of the vertical sensitivity of the oscilloscope to one of nine levels ranging from 0.05 to 20 volts per inch. In addition, Test Lead MX-2681/UP contains a three-step attenuator which permits adjustment of the vertical sensitivity from 0.05 to 2000 volts per inch. The VIDEO SENS control is an additional continuously-variable vertical sensitivity control which operates within each range setting of the VOLTS/IN switch. It is normally set to the detented CAL position so that calibration of the selected level is accurate.

The starting point of the horizontal scanning line can be delayed with respect to the synchronizing trigger by means of the three SWEEP DELAY controls on the Crystal Mark and Sync unit. The SWEEP DELAY RANGE switch has six positions for selecting delay ranges from 0 to 750 microseconds. The COARSE and FINE controls permit accurate adjustment of the delay time within each range. Accurate measurement of the sweep delay can be made by pressing down on the momentary-contact DELAY STROBE SWEEP switch on the Sweep and Intensity Mark unit and using the intensity markers for time measurement. This switch also provides a means of presetting the sweep delay prior to examination of pulses or pulse trains.

The INTENSITY MARKS RANGE switch and the LEVEL control provide a means for superimposing intensity modulation-type markers (in the form of small bright spots spaced 0.1, 1, 5, or 50 microseconds apart) upon the displayed pattern. The 1- and 0.1-microsecond markers may be used together; the 1-microsecond markers are recognizable by their size; they are larger than the 0.1-microsecond markers. Also, the 1-microsecond marker height is adjustable by the LEVEL control, while the level of the 0.1-microsecond markers remains constant.

Another set of markers is generated by a crystal controlled oscillator and are available in the form of video "pips" spaced either 1 or 1.45 microseconds apart on the displayed pattern. These are selected by placing the SYNC SELECT switch in either the INT 1.45 or the INT 1.00 position. The amplitude of these markers is controlled by the XTAL MARK LEVEL control. The 1-microsecond markers are provided primarily for checking the interrogation code pulse spacing, and the 1.45-microsecond markers are used primarily for checking the spacing of SIF pulse trains. These video markers are applied to alternate sweeps and the viewed signal is applied to the remaining sweeps so that distortion of the viewed pulses does not occur.

The SYNC SELECT switch enables the operator to select one of five types of triggering to be used for establishing a zero time reference for synchronizing the test unit. When using an external trigger signal, the SYNC SELECT switch is set to either the EXT + or the EXT - position, depending upon the polarity of the external trigger pulse. When the SYNC SELECT switch is in either the INT 1.45 or the INT 1.00 position, the test unit is synchronized by the internal crystal controlled oscillator output at either 689 kHz or 1000 kHz. When the SYNC SELECT switch is in the INT position, the test unit is synchronized by the internal free-running blocking oscillator, the pulse repetition frequency of which is adjustable continuously from 15 to 4100 pps by means of the PRF control.

The trigger pulses used to synchronize the test unit can be delayed from 0 to 750 microseconds by means of the TRIGGER DELAY RANGE switch and the COARSE and FINE controls. The delayed positive-going trigger pulse is available at the DELAYED TRIGGERS connector on the Crystal Mark and Sync unit. The trigger delay can be measured visually on the oscilloscope by pressing down on the DELAY STROBE TRIGGER momentary-contact

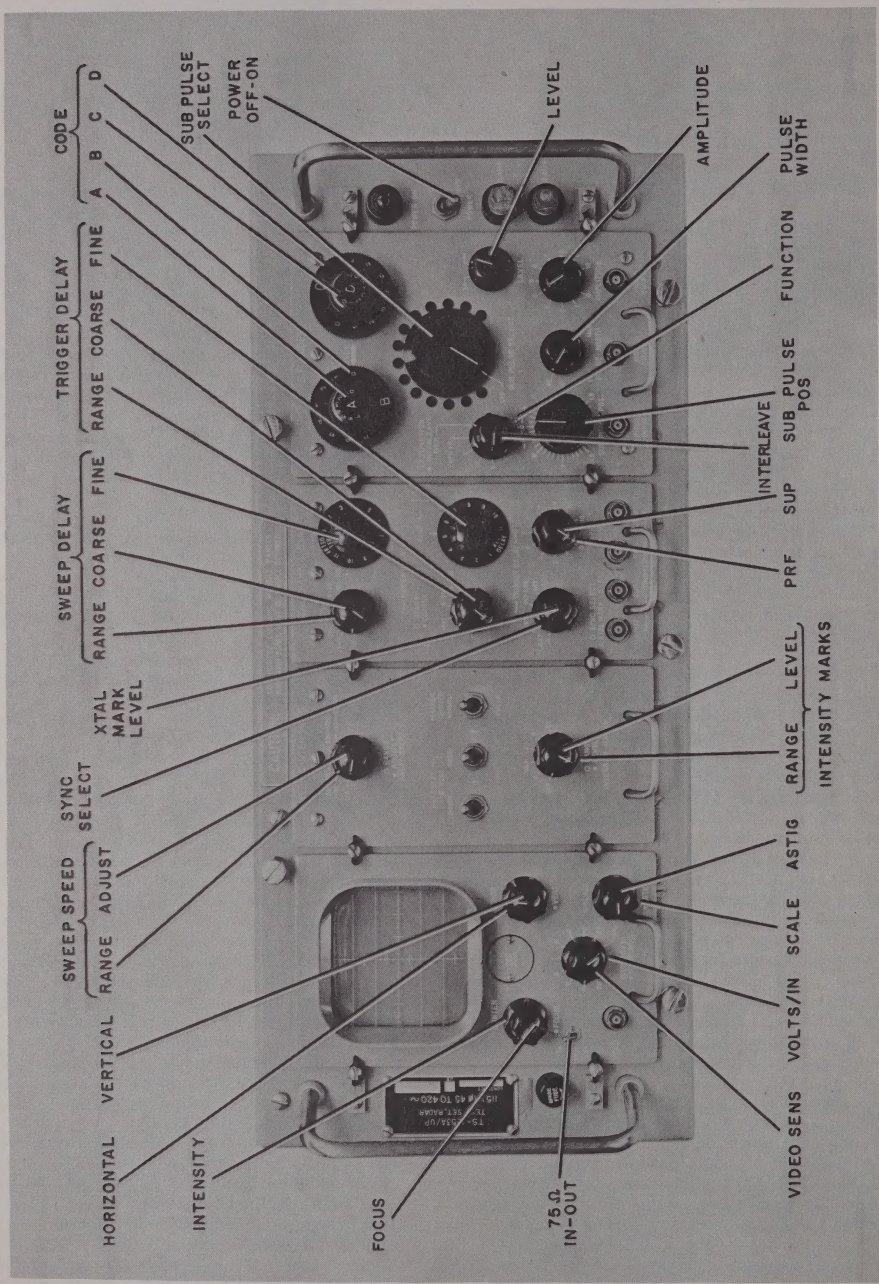


Figure 3-1. Radar Test Set TS-1253A/UP, Front Panel Controls

switch and counting the intensity-type markers superimposed upon the trace. The zero-time trigger or delayed trigger can be used to synchronize the SIF Coder, the Interrogation Coder, or the equipment under test.

A suppressor pulse is available at the SUP TRIGGERS connector. The width of this pulse is adjustable between 2 and 220 microseconds by means of the SUP control. This pulse can be used to gate off ("suppress") certain external equipment when desired.

It may be desired to delay the starting point of the intensity markers by the same amount that the sweep is delayed. This can be accomplished by setting the MARKER TRIGGER switch to the SWEEP position. When this is done, the same delayed sweep trigger signal is used to trigger both the oscilloscope sweep and the intensity marker circuits. When the MARKER TRIGGER switch is in the NORMAL position, the intensity marker circuits are triggered at zero time.

(2) SIF CODER.

(a) SIF CODE SYSTEM. - The SIF code utilizes the binary system of number notation wherein all numbers are represented by combinations of only two symbols, "0" and "1". In the SIF pulse code, a voltage pulse represents a binary "1", while the absence of a pulse represents a binary "0"

In the binary system of number notation, a "1" symbol in the first place to the left of the decimal point represents a quantity of one, just as in the conventional decimal system. In the second place (corresponding to "tens" place in the decimal system) a "1" symbol represents a quantity of two (double that of the first place). The value of the "1" symbol is doubled with each place it is moved away from the decimal point. Numerical values not represented by a "1" symbol in a single place are represented by combinations such that the sum of the quantities represented equals the desired number. Thus, in binary notation, "111" represents the quantity seven (4+2+1).

SIF numerical codes may contain up to four Arabic numerals. The numerals used are 0 through 7. The numeral in each of the four places is independently encoded into the binary form for transmission as a series of pulses.

It was shown that the number 7, which is the largest used in the SIF code, can be represented in the binary system by means of three symbols (and three places). The system needed for handling the SIF code, then, is a "3-bit" binary system. Since it is desired to transmit as many as four different numbers in some cases, it is necessary to use up to twelve (4 by 3) information pulses in the pulse train (not including the start and stop bracket pulses which play no actual part in the numerical code).

For efficiency, the space within the pulse train is allocated in such a manner that the three bits for the four numerals are interlaced (see figure 3-2). The four numerals in a code number are given the designations A, B, C, and D, while the "bits" are numbered according to the value of the three binary places used (1, 2, and 4). Thus a pulse identified as "A4" in a pulse train indicates that a binary "1" is present in the "fours" place for the first numeral on the left, while the absence of a pulse at this point in the train indicates a binary "0" in the "fours" place for this numeral.

The space between the bracket ("framing") pulses is divided into two equal parts on either side of a normally unused center space ("X"). The front half (following the start pulse) is used for interlaced C and A pulses, while the second half is used for interlaced B and D pulses. The interval between the leading edges of the bracket pulses is 20.3 microseconds. The length of each pulse is 0.45 microseconds, and the interval between leading edges of adjacent pulses is 1.45 microseconds.

Mode 1 code numbers consist of selected numbers from 1 through 73. Only five of the information pulse positions are used in mode 1 (the B4 position is not used). See figure 3-3 for the mode 1 reply code pattern.

Mode 2 code numbers include both 6 and 12-pulse numbers, using selected numbers from 0000 through 7777. Groups A and B are used for 6-pulse code numbers, while all four groups (A, B, C, and D) are used for 12-pulse code numbers. See figure 3-3 for the mode 2 reply code patterns.

Mode 3/A code numbers consist of both 6 and 12 pulse numbers, using selected numbers from 0000 through 7777. Groups A and B are used for 6-pulse code numbers, while all four groups (A, B, C and D) are used for 12-pulse code numbers. See figure 3-3 for the mode 3/A reply code patterns.

The mode C (altitude) code is similar to the mode 2, 12-pulse code; however, no D1 pulses are used and an SPI (Special Position Identification) pulse which is the same as the ID pulse (figure 3-3), is used with each D4 pulse.

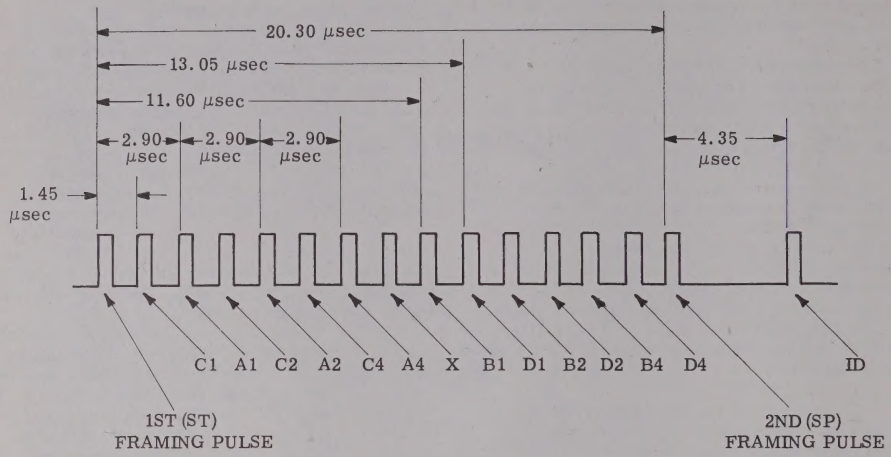
(b) SIF PULSE CODE GENERATION. The SIF Coder generates SIF code pulse trains of the type illustrated in figure 3-2 and 3-3. These include two framing pulses, up to twelve information pulses, and optionally, an X pulse or an ID pulse.

The width of the SIF Coder pulses is adjusted by means of the PULSE WIDTH control from 0.3 to 1.0 microsecond. Nominal pulse width is 0.45 microsecond. The amplitude of the pulses available at the MOD DRIVE connector depends upon the setting of the LEVEL switch. The pulse amplitude available at the VARI OUTPUT connector is controlled by the continuously variable AMPLITUDE control and the LEVEL switch.

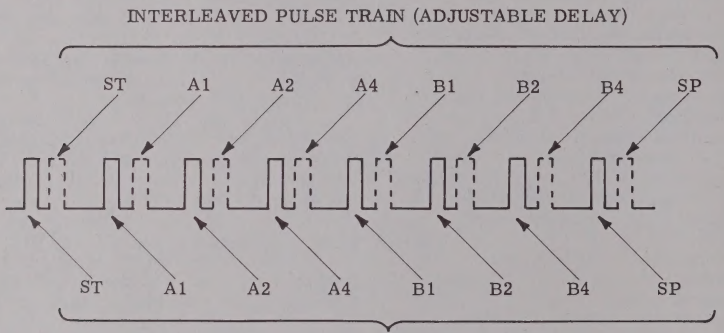
The two framing pulses ("start" and "stop" bracket pulses) are present in all pulse trains regardless of the setting of the controls. The presence of the six information pulses on each side of the pulse train center (figure 3-2) is determined by the settings of the four CODE number selectors at the top of the front panel. The switches are designated by letters A, B, C, and D corresponding to the four pulse groupings. Any combination of the twelve information pulses can be made up by use of these four selectors. Table 3-1 shows the pulse combinations obtained for each of the seven settings of the CODE number selectors.

The output to be made available at the MOD DRIVE and VARI OUTPUT connectors is determined by the FUNCTION selector switch. In the N position, a normal pulse train (two framing pulses and information pulses as set by the four CODE

NOTE: NOMINAL PULSE WIDTH IS 0.45 μSEC



A. AVAILABLE SIF CODE PULSE POSITIONS (SINGLE TRAIN)



B. TYPICAL INTERLEAVED PULSE TRAIN (CODE 7700)

Figure 3-2. General SIF Pulse Code Pattern

number selectors) is supplied. Moving the FUNCTION switch to the ID position adds the ID pulse (figure 3-3) after the pulse train. In the X position, the ID pulse is removed and the X or center pulse appears. In the EMER position, each prf trigger pulse produces a pair of bracket pulses with the selected information pulses between them, followed by three more pairs of bracket pulses without any information pulses, each pair spaced 4.35 usec apart. In the EMER +X position, another pulse ("X") is inserted into the center of the information pulses.

Any pulse in a train except the start pulse and the ID pulse can be removed (one at a time) and a pulse of identical characteristics which is separately variable in position can be substituted for it. The pulse for which substitution is to be made is selected by the SUB PULSE SELECT switch. The SUB PULSE POS control varies the position of the substitute pulse ±1.6 microseconds around the normal position of the removed pulse.

An output consisting of two identical reply signals in which the pulse trains are overlapped or interleaved can be obtained by placing the FUNCTION selector in the I position. The relative spacing of the pulses in the two pulse trains can be varied by means of the INTERLEAVE control.

(3) POWER SUPPLY.- Operating voltages for Radar Test Set TS-1253A/UP are supplied by a power supply located at the rear of the unit. Application of input power to the unit is controlled by the POWER switch located at the right side of the

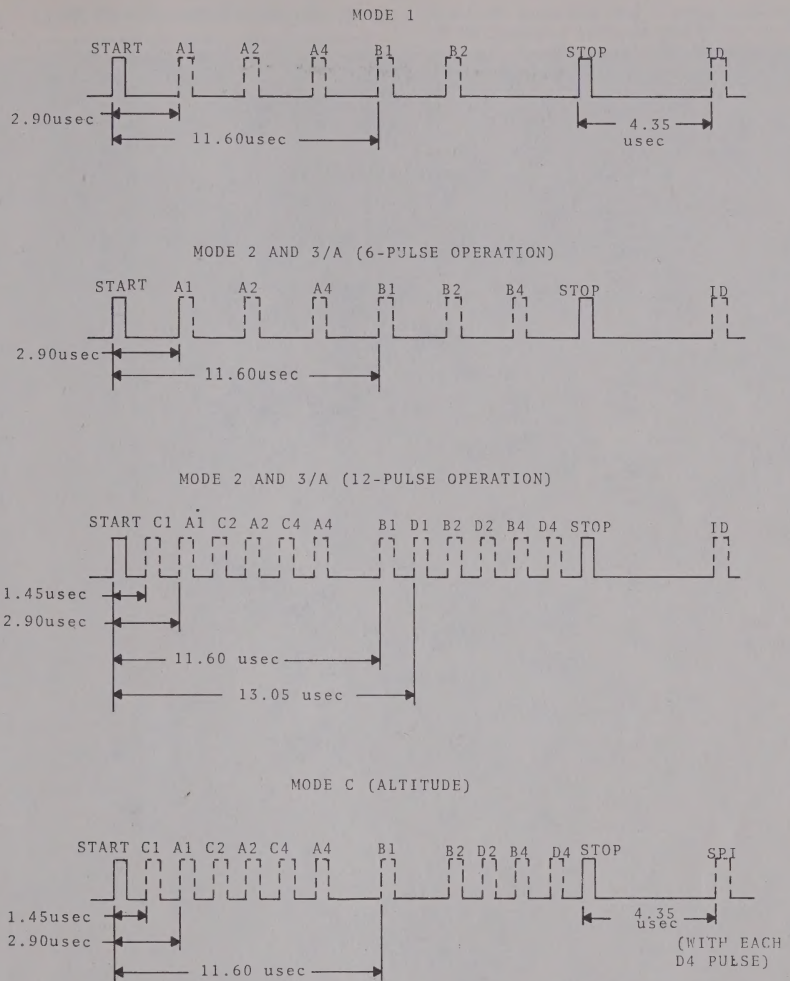


Figure 3-3. Pulse Positions Available in Standard SIF Modes

front panel. A red panel light marked POWER ON indicates that the unit is energized. Located immediately below the POWER switch are the primary power fuses.

c. CODER SIMULATOR SM-197A/UPM-98.- Coder Simulator SM-197A/UPM-98 comprises the bottom half of Radar Test Set AN/UPM-98A. Its basic functional sections include an rf signal generator, a pulse calibrator, a wavemeter, a demodulator, a prf counter, a mode 4 reply decoder, and a pulse generator ("coder") capable of simulating the interrogation pulse pairs of the Mark X IFF System, plus an ISLS pulse if desired. Figure 3-4 is a view of the Coder Simulator front panel showing all the operating controls.

(1) RF OUTPUT.- The rf output signal can be adjusted in frequency from 925 to 1225 megahertz by means of the SG FREQUENCY control. This signal is available at the SG OUT connector. The output signal is fed through a variable attenuator which is controlled by the ATTENUATION knob. The chosen amount of attenuation in decibels below one volt can be read on the associated digital indicator.

The rf output signal can be modulated using an internally generated pulse signal by setting the Function Selector switch on the Interrogation Coder to the INT position. External modulating signals are applied through the MOD connector. For modulation with external pulses from 3 to 20 volts in amplitude, the Function Selector switch is set to the MOD-LOW position. For external pulses 20 to 35 volts in amplitude, the switch is set to the

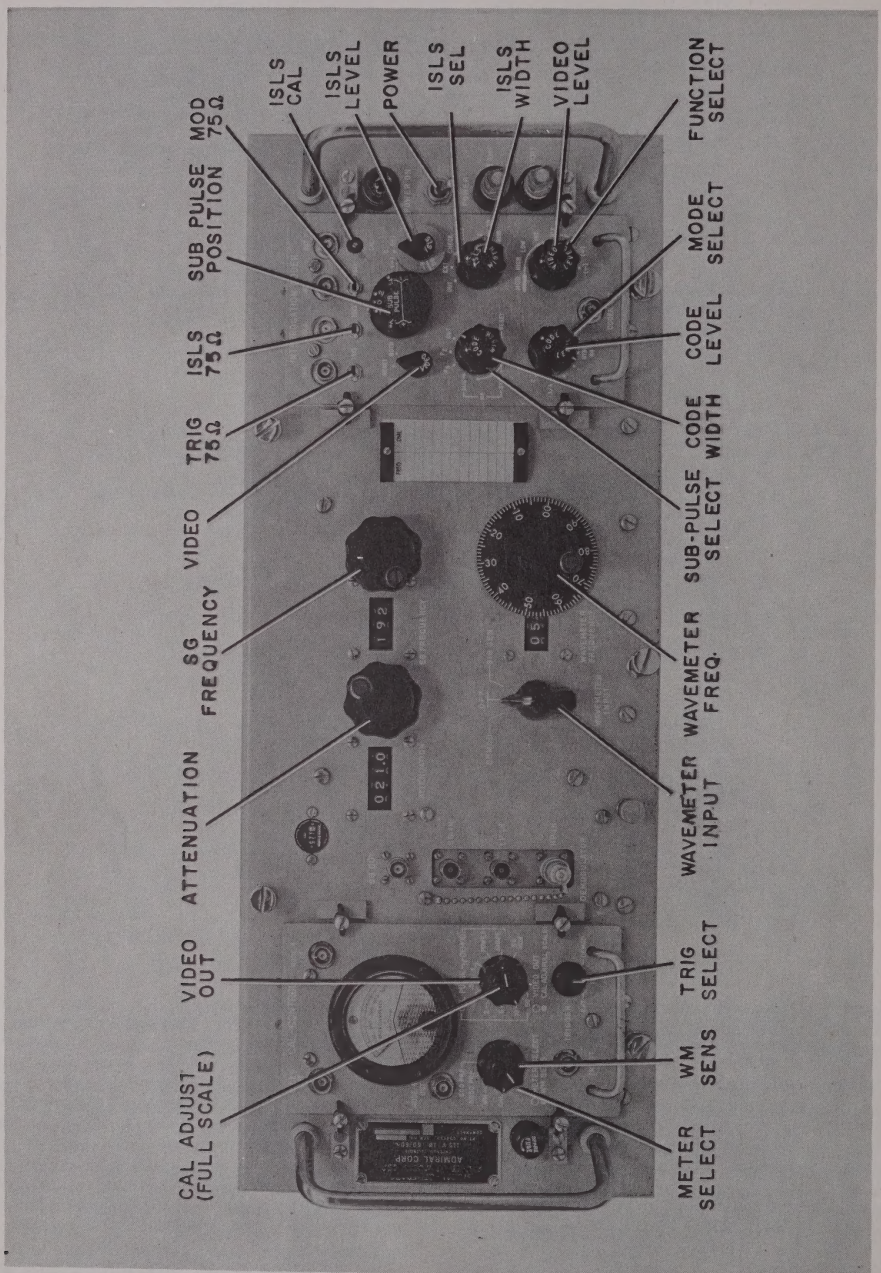


Figure 3-4. Coder Simulator SM-197A/UPM-98 Front Panel Controls

TABLE 3-1. CODE NUMBER SELECTOR CHART

CONTROL POSITION	PULSES ON	CONTROL POSITION	PULSES ON
A1	A_1	B1	B_1
A2	A_2	B2	B_2
A3	A_1, A_2	B3	B_1, B_2
A4	A_4	B4	B_4
A5	A_1, A_4	B5	B_1, B_4
A6	A_2, A_4	B6	B_2, B_4
A7	A_1, A_2, A_4	B7	B_1, B_2, B_4
C1	C_1	D1	D_1
C2	C_2	D2	D_2
C3	C_1, C_2	D3	D_1, D_2
C4	C_4	D4	D_4
C5	C_1, C_4	D5	D_1, D_4
C6	C_2, C_4	D6	D_2, D_4
C7	C_1, C_2, C_4	D7	D_1, D_2, D_4

MOD-HIGH position. With the Function Selector switch in the MOD-MIX position, mixed video signal is applied to the modulator. When in the TEST position, the mixed video is applied to the CODER OUT connector. With the switch set to (+) or (-), the modulating signal is removed from the rf signal generator and switched to the CODER OUT connector on the Interrogation Coder. Delay in the signal due to inherent delay in the rf circuitry is not more than 0.3 microsecond.

(2) WAVEMETER.- When the WAVEMETER INPUT switch is in the SIG GEN position, the internal rf signal fed into the SG IN DEMODULATOR connector is applied to the wavemeter circuitry. The rf signal frequency can be measured within ±0.7 megahertz by setting the METER SELECT switch (on the Calibration-Control unit) to the WM position and adjusting the WAVEMETER FREQUENCY control until the needle of the Calibration-Control meter dips, indicating the resonance point. The actual frequency of the measured signal is then determined by referring to the Book of Calibration Charts furnished with the equipment. When the WAVEMETER INPUT switch is the DEMOD position, the frequency of rf signals applied to the demodulator can be measured in a similar manner. These may be either external or internal signals fed into one of the DEMODULATOR connectors.

(3) DEMODULATOR.- Internal or external pulse-modulated rf signals can be demodulated by applying them to one of the DEMODULATOR connectors (SG IN, LP IN, or HP IN). Low power (0.5 to 35 watt) external rf signals are applied to the LP IN connector and high power (35 to 3500 watt) signals are applied to the HP IN connector. The video signal resulting from the demodulation of the rf signal becomes available at the VIDEO OUT connector. With the VIDEO OUT switch in the POWER position, the peak pulse amplitude of the video signal is available for power measurement on the oscilloscope. In the SHAPE position, a video output having minimum distortion is available for waveshape observation and measurement. With the VIDEO OUT switch in the SG MON position a small portion of the rf output signal at the SG OUT connector goes through the demodulator and the resulting video is available at the VIDEO OUT connector for monitoring purposes.

(4) RF POWER MEASUREMENT.- To measure rf power, the VIDEO OUT control is placed in the POWER position and the Demodulator Calibration Curves in the Book of Calibration Charts are used to translate the oscilloscope voltage reading to a power reading. These curves are plotted for peak amplitude (volts versus decibels above one watt) at the VIDEO input connector on the Display unit. A correction factor for different frequencies must be added to or subtracted from the demodulator chart reading to arrive at an exact power measurement. The relative accuracy of the demodulator power measurement is ±0.5 db over the range of 0.5 to 3500 watts peak pulsed power at frequencies from 925 to 1225 megahertz. The CG-530B/U cable supplied with the Radar Test Set should be used for this power measurement, otherwise inaccuracies will be introduced.

CAUTION

The average power applied to the LP IN connector should not exceed 0.25 watt for continuous signals. Intermittent signals having average powers up to 10 watts may be tolerated for periods up to five minutes if they are not repeated more often than at 15 minute intervals.

(5) SG OUT, SG IN, LP IN, AND HP IN CONNECTORS.- When the SG OUT (signal generator out) connector is jumpered by cable CG-1848/U to the SG IN (signal generator in) connector, the attenuated rf signal becomes available at the LP IN (low power in) connector. The internal attenuation between the SG IN and LP IN connectors is approximately 13 db and the attenuation between the LP IN and HP IN connectors is approximately 20 db. The level of the internal rf signal is too low to be demodulated by this circuit; however, high power reply signals will be demodulated and the result will appear at the VIDEO OUT connector on the Calibration-Control unit.

(6) MODE 4 REPLY DECODING.- Radar Test Set AN/UPM-98A has a capability for decoding 3-pulse Mode 4 reply signals (3-pulse trains with a 1.8 microsecond spacing between adjacent pulses), producing a single pulse output signal. The Mode 4 decoding circuitry is located in the calibration-control unit. The MODE 4 OUTPUT connector (which has an impedance of 90 ±10 ohms) provides an output up to 5 volts in amplitude. The positive

output has a duration of 0.5 ± .1 microseconds, with a rise time of 0.1 microsecond and a fall time of less than 0.15 microsecond.

(7) PRF COUNTER.- This pulse counter is used to determine the repetition frequency of the internal trigger signal, the external trigger signal, or the demodulator output signal, as selected by the front panel TRIGGER switch. The BNC-type INPUT connector serves as an input to both the pulse counter and the video calibrator. There are two pulse counter ranges: 0 to 500, and 0 to 5000 pps, selectable by the METER SELECT switch. The accuracy of the pulse counter is within plus or minus 5 percent at full scale and within plus or minus 10 percent at 1/10 full scale. External triggers to be counted should have the following characteristics:

(a) Polarity - positive
(b) Repetition rate - 15 to 4100 pps
(c) Pulse duration - 0.3 to 25 usec
(d) Amplitude - 20 to 150 volts
(e) Rise Time - less than 0.5 usec per volt

(8) CALIBRATION PULSES.- When the METER SELECT switch is in the CAL position, the test set makes available positive calibrated pulses at the VIDEO OUT connector on the Calibration-Control unit. These pulses are of 2.5 ± 0.5 usec duration and of 0.1, 0.5, 1, 2, 5, 10, or 50 volts amplitude as selected by the VIDEO OUT switch. These pulses may be used for calibrating the oscilloscope vertical pattern height. The calibrator circuit may be triggered by internal pulses, by an external input, or by the demodulator output, depending upon the TRIGGER switch position. The calibrator will operate at frequencies from 15 to 4100 pulses per second.

(9) INTERROGATION CODER.- The Interrogation Coder simulates interrogations used by Mark X type IFF equipment. The coder output is determined by the setting of the Mode Selector switch. Table 3-2 shows the types of coder output pulses available. Front panel controls are shown in figure 3-4.

(10) POWER SUPPLY.- Operating power is supplied to all circuits of Coder Simulator SM-197A/UPM-98 by a power supply located at the rear of the panel-chassis assembly. The POWER switch is located on the right end of the front panel. A POWER ON indicator light is above the switch. Fuses 8F1 and 8F2 are mounted below the switch. A spare fuse is mounted at the left of the front panel.

3-2. THEORY OF TESTS MADE WITH RADAR TEST SET AN/UPM-98A.

A brief explanation of some of the tests made with Radar Test Set AN/UPM-98A is given below.

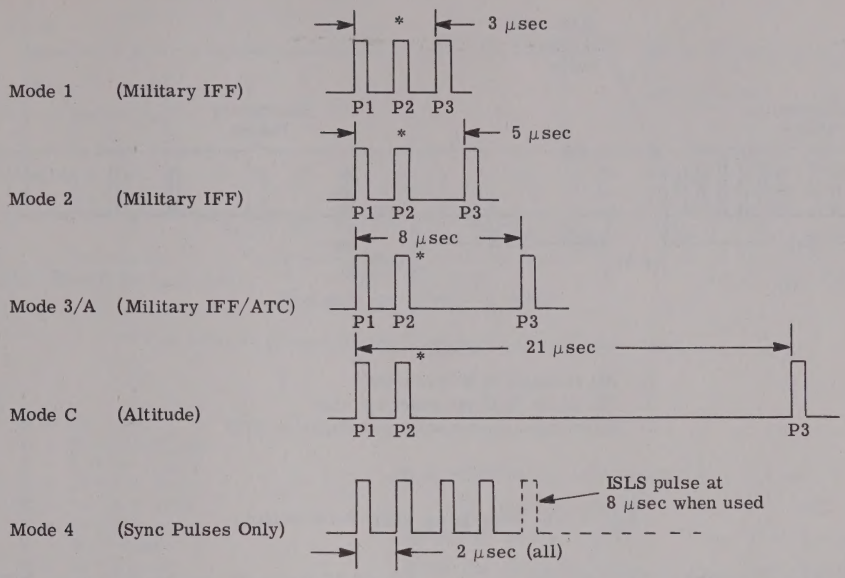
a. SIMULATION OF CODED INTERROGATION SIGNALS.- With the exception of the Mode 4 interrogation signal, the interrogations are made up of a simple code involving two pulses spaced to indicate the mode of interrogation (figure 3-5). Simulated signals of this type are supplied by the Interrogation Coder in Radar Test Set AN/UPM-98A. For Mode 4 interrogations, the pulse modulation signal must be obtained from an external source. This Mode 4 code signal may contain up to 37 pulses (including four synchronizing pulses which are supplied by this equipment). The special case of a simulated interrogation signal containing an ISLS (Interrogation Side Lobe Suppression) pulse is explained below.

(1) ISLS CHECKING.- To prevent a transponder from responding erroneously to an interrogation signal which is transmitted on a lobe other than the main lobe of an essentially directional sending antenna, another signal is also sent out from an omnidirectional antenna (or "sum and difference" antenna array) for use as a reference. Since the signal from an omnidirectional antenna will have the same strength in all directions, it is possible to distinguish the main lobe signal from the side lobe signals by means of their relative amplitudes. In the "sum and difference" system the difference will be accentuated by the cardioid reference pattern. The AN/UPM-98A has the capability to provide signals for checking transponders designed to operate in this manner. A simulated ISLS pulse is added to the normal interrogation pulses for this purpose (figure 3-5). By varying the relative amplitudes of the pulses, the reception pattern from any type of antenna lobe can be simulated. The position of the ISLS pulse may be varied ± 0.8 usec from nominal by means of the SUB PULSE POSITION control. When this control is in the detented "0" position, the ISLS pulse follows the P1 pulse by 2 ± 0.05 usec.

b. SIMULATION OF CODED REPLY SIGNALS.- The basic IFF response signal consists of a pair of pulses spaced 20.3 microseconds apart. (These pulses are sometimes referred to as "framing" pulses or start and stop "bracket"

TABLE 3-2. INTERROGATION CODER OUTPUT PULSES

MODE SELECTOR SWITCH POSITION	TYPE OF OUTPUT	PULSE DURATION	PULSE SPACING (Microseconds)
Sync M4	4 sync pulses	0.4 to 0.6 usec (0.5 nom)	1.3 to 2.7 (2 nom)
1	Paired pulses	0.35 to 1.3 usec (.8 nom)	2.3 to 3.7 (3 nom)
2	Paired pulses	0.35 to 1.3 usec (.8 nom)	4.3 to 5.7 (5 nom)
3/A	Paired pulses	0.35 to 1.3 usec (.8 nom)	7.3 to 8.7 (8 nom)
C	Paired pulses	0.35 to 1.3 usec (.8 nom)	20.3 to 21.7 (21 nom)



NOTES:

1. * P2 present when ISLS is used and is spaced 2 μsec from P1 in all cases shown above.
2. All pulse widths 0.8 μsec, except Mode 4 sync pulses which are 0.5 μsec wide.

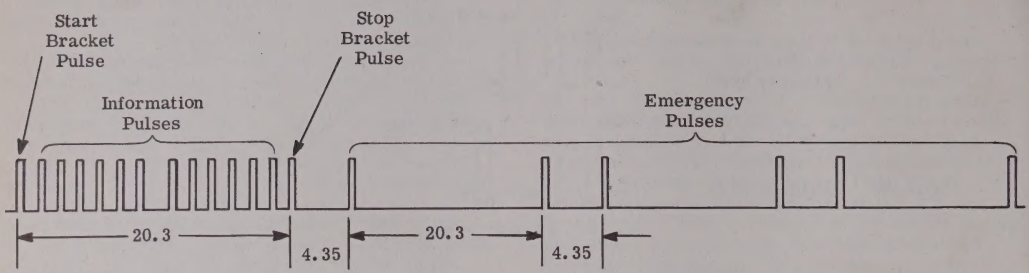
Figure 3-5. Interrogation Pulse Patterns

pulses.) Additional information pulses (up to 12) are inserted between the bracket pulses according to the SIF code plan (figure 3-2). Simulated signals of this type are supplied by the SIF Coder. Certain variations to this basic code pattern for emergency and special identification purposes are explained below.

(1) EMERGENCY REPLIES. - In order to indicate an emergency condition, a transponder may be operated so that it transmits a special readily-identified signal. This signal consists of one pair of bracket pulses which enclose any preselected information pulses, followed by three additional (empty) pairs of pulses having the same characteristics as the bracket pulse, with a 4.35 ± 0.1 microseconds separation between the pairs (figure 3-6). This pulse group will be repeated once for each prf trigger period. Radar Test Set AN/UPM-98A has the capability of simulating this emergency signal for testing interrogator-receivers designed to receive this type of signal. In addition to this simulated emergency signal, the AN/UPM-98A has a capability for inserting an "X" pulse into the train (in the center of the information pulses). Although the X pulse is not normally used in actual transponder replies, this signal may be used for special tests requiring it.

(2) IDENTIFICATION OF POSITION REPLIES. - In order to identify an individual aircraft (locate its position on the radar screen) in a group of aircraft all replying with the same basic code number, a special identifying signal may be sent out by the transponder. This signal consists of the basic coded pulse train, followed by an additional single ID pulse (having the same characteristics as the bracket pulses) spaced a distance of 24.65 ± 0.1 microseconds after the first bracket pulse (figure 3-2). This pulse group will be repeated once for each prf trigger period. The AN/UPM-98A has the capability of simulating this signal for testing interrogator-receivers designed to receive it.

(3) MODE IDENTIFICATION PULSES. - When a complex video signal containing two or more replies to interrogations in more than one mode is fed to the decoder from the IFF/SIF receiver, it is necessary to correlate each reply with the mode of transmission to which it responded. This mode



NOTES

1. All spacings in microseconds
2. All pulses 0.45 microsecond wide
3. Information pulses show coded number 7777

Figure 3-6. Emergency Reply Pulse Pattern

identification is accomplished by "labeling" the received pulse train with a set of the interrogation pulses which were sent out by the interrogating transmitter. (When an ISLS pulse is present in the interrogation, it will also appear in the mode identification signal.) The identification pulses are superimposed upon the video signal so that the leading edge of the last of the identification pulses is 14 microseconds ahead of the first framing pulse (figure 3-7). (First framing pulse 40 ± 4 usec after 0 trigger, last identification pulse 26 ± 1 usec from 0 trigger). For all modes but Mode 4, the Identification pulses will consist of two pulses (plus a third pulse when ISLS is used). For Mode 4, they will consist of four pulses spaced two microseconds apart (corresponding to the Mode 4 synchronizing pulses). In Mode 4, a fifth pulse will be present 8 microseconds after the first identification pulse when ISLS is used. Radar Test Set AN/UPM-98A has the capability for simulating signals of this type for testing equipment designed to use these signals.

NOTE

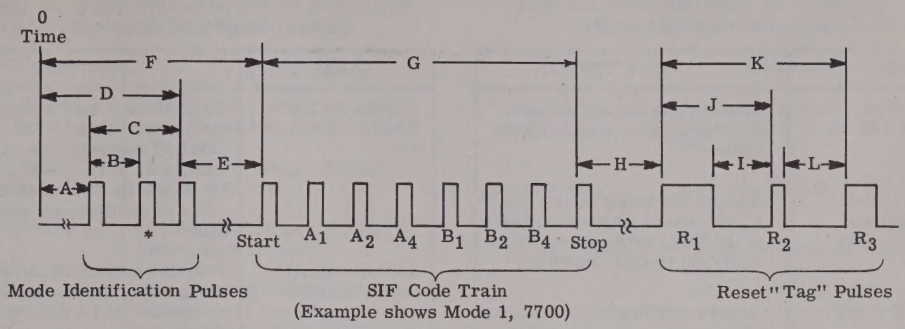
The mode identification pulses are sometimes called "tags", but to avoid confusion with the reset tag pulses, they will be called mode identification pulses herein.

(4) RESET TAG SIGNAL. - When interrogations and replies are transmitted in two or more interlaced modes, the transponder sends a signal indicating the end of the reply, enabling the decoder to reset to the normal condition where it awaits the arrival of the next reply in another mode. This reset signal consists of three "tag" pulses (figure 3-7) having distinctive pulse widths and spacings. The first pulse is 8 ± 0.25 usec wide, the second is 2.0 ± 0.25 usec wide, and the third is 4 ± 0.25 usec wide. The first pulse is placed 20 usec after the leading edge of the last pulse of the coded pulse train, the second pulse 10 ± 0.1 usec later, and the third is 15 ± 0.1 microseconds later. When only a normal pulse train is present in the reply, the first reset tag pulse will follow the stop bracket pulse by 20 usec; when the ID pulse is present, the first reset tag pulse will follow the ID pulse by 20 usec, and when an emergency train is present, the first reset tag pulse will follow the last pulse of the third empty pulse pair by 20 usec (figure 3-7). Radar Test Set AN/UPM-98A simulates this signal, providing a set of three tag pulses which may be superimposed upon the composite video signal.

(5) INTERLEAVED REPLY SIGNALS. When checking the capability of a receiver to process multiple replies, two separately variable reply signals are injected simultaneously into the receiver under test. The spacing of the two pulse signals is varied to check that the signals are individually processed and decoded correctly within the specified range of spacing. Also the pulse spacing is adjusted to overlap so as to cause garbling, checking the ability of the receiver to recognize and reject this kind of signal. The AN/UPM-98A has the capability of producing a signal of this kind for making such tests.

3-3. PREPARATION FOR USE.

If the test set has not previously been prepared for use, or if it has been relocated, follow the instructions in Section 2 of this manual. To prevent damage to the equipment, give special attention to the data regarding input voltage adjustment, electrical grounding of the equipment, and preliminary control settings.



*This pulse is present in simulated signal when ISLS is used.

A = 23 μsec
B = 2.0 ±0.05 μsec
C = 3.0 ±0.1 μsec
D = 26 ±1.0 μsec
E = 14 ±1.0 μsec
F = 40 ±4 μsec
G = 20.3 μsec
H = 20 ±2 μsec
I = 2 μsec
J = 10.0 ±0.1 μsec
K = 15.0 ±0.1 μsec
L = 3 μsec

Mode Identification Pulse Width — 0.8 μsec
SIF Code Pulse Width — 0.45 μsec
Reset Tag Pulse R1 Width — 8 ±0.25 μsec
Reset Tag Pulse R2 Width — 2 ±0.25 μsec
Reset Tag Pulse R3 Width — 4 ±0.25 μsec

Figure 3-7. Typical Composite SIF Video Pulse Pattern with Mode Identification Pulses and Reset Tag Pulses Added.

3-4. OPERATING PROCEDURES.

a. DESCRIPTION OF CONTROLS. - All controls required for normal operation of the test set are located on the front panels and are illustrated in figures 3-1 and 3-4. Tables 3-3 through 3-10 list all controls required by the operator for normal use of the equipment. The right column of the table describes the function of each control.

b. SEQUENCE OF OPERATION.

(1) BEFORE USE.

(a) PRELIMINARY CONTROL SETTINGS. - Before the test set is energized, operating controls should be set to the positions indicated in table 2-1. These settings ensure correct operation and prevent accidental damage to the test set or to the equipment being tested. Begin each testing procedure with these settings and change them only as required by the test being performed.

(b) APPLICATION OF POWER. - After controls have been set as shown in table 2-1, apply external power as explained in paragraph 2-3. Place POWER switches of Radar Test Set TS-1253A/UP and Coder Simulator SM-197A/UPM-98 in ON position. The POWER ON indicator lamp above each switch should light.

TABLE 3-3.
DISPLAY UNIT CONTROLS AND INDICATORS

NAME	FUNCTION
INTEN(Intensity) Control 1R74A	Adjusts brilliance of oscilloscope trace
FOCUS Control 1R74B	Controls focus (sharpness) of oscilloscope trace
HOR(Horizontal) Control 1R47B	Adjusts horizontal position of oscilloscope pattern
VERT (Vertical) Control 1R47A	Adjusts vertical position of oscilloscope pattern
75Ω switch 1S1	Switches in and out 75-ohm termination across VIDEO input connector
VOLTS/IN Switch 1S2	Nine-position rotary switch. Selects one of nine oscilloscope vertical sensitivites. Calibrated in volts per inch

TABLE 3-3. DISPLAY UNIT CONTROLS AND INDICATORS (Cont.)

NAME	FUNCTION
VOLTS/IN Switch 1S2 (Cont.)	(Determines display pattern size for a given signal amplitude)
VIDEO SENS (Sensitivity) Control 1R41	Adjusts the height of oscilloscope pattern within the ranges of the VOLTS/IN switch. (Normally set to CAL position.)
SCALE Control 1R59B	Adjusts brightness of illumination of the scale on the face of the cathode ray tube
ASTIG (Astigmatism) Control 1R59A	Corrects for uneven focusing on oscilloscope

TABLE 3-4. SWEEP AND INTENSITY MARK UNIT CONTROLS AND INDICATORS

NAME	FUNCTION
SWEEP SPEED RANGE 2A3	Determines the range of oscilloscope sweep speeds to be used
SWEEP SPEED ADJUST 2R29 A&B	Adjusts sweep speed within the range setting of the SWEEP SPEED RANGE switch
DELAY STROBE TRIGGER Switch 2S1	Permits temporary return to "zero" time triggers while displaying a video mark for the location of the delayed trigger
DELAY STROBE SWEEP Switch 2S4	Permits temporary return to "zero" time sweep while displaying a mark for the beginning of delayed sweep
MARKER TRIGGER NORMAL SWEEP Switch 2S2	Permits intensity markers to be delayed the same amount as sweep
INTENSITY MARKS RANGE Switch 2S6	Selects range of spacing between intensity marks
INTENSITY MARKS LEVEL Control 2R95	Adjusts brightness of intensity marks on the display

TABLE 3-5. CRYSTAL MARK AND SYNC UNIT CONTROLS AND INDICATORS

NAME	FUNCTION
SWEEP DELAY RANGE Switch 3S3	Six position rotary switch concentric with SWEEP DELAY COARSE control. Positions marked 0, 1-11, 11-21, 21-31, 5-50, 50-750. Determines range of oscilloscope sweep delay
SWEEP DELAY COARSE 3R100	Provides coarse adjustment of sweep delay within range set by SWEEP DELAY RANGE switch in coarse positions (5-50 and 50-750)
SWEEP DELAY FINE Control 3L5	Provides fine adjustment of sweep delay within fine ranges set by SWEEP DELAY RANGE switch
TRIGGER DELAY RANGE Switch 3S2	Four-position rotary switch concentric with TRIGGER DELAY COARSE CONTROL. Positions marked 0, 1-11, 5-50, 50-750. Determines range of oscilloscope trigger delay
TRIGGER DELAY COARSE CONTROL 3R72	Provides coarse adjustment of trigger delay within coarse range (5-50 and 50-750) set by the TRIGGER DELAY RANGE switch
TRIGGER DELAY FINE Control 3L3	Provides fine adjustment of trigger delay within fine ranges set by the TRIGGER DELAY RANGE switch
SYNC SELECT Switch 3S1	Determines type of synchronizing trigger to be used to establish "zero time"
XTAL MARK LEVEL Control 3R64	Controls amplitude of markers generated by crystal controlled oscillator
PRF Control 3R38A	Adjusts pulse repetition frequency of internal triggers.
SUP (Suppress) Control 3R38B	Adjusts duration length of suppressor pulse

TABLE 3-6 SIF CODER CONTROLS AND INDICATORS

NAME	FUNCTION
CODE Switch 4S5A	Selects "A" pulses for SIF pulse code trains

TABLE 3-6. SIF CODER CONTROLS AND INDICATORS (Cont.)

NAME	FUNCTION
CODE Switch 4S5B	Selects "B" pulses for SIF pulse code trains
CODE Switch 4S4A	Selects "C" pulses for SIF pulse code trains
CODE Switch 4S4B	Selects "D" pulses for SIF pulse code trains
FUNCTION Selector 4S1	Six-position rotary switch. Determines type of output appearing at MOD DRIVE and VARI OUTPUT connectors. Positions marked: I — Interleaved Code pulse train N — Normal code pulse train ID — Normal code pulse train plus ID (Identification of position) pulse X — Normal code pulse train plus X (center) pulse EMER +X — Normal code pulse train plus X pulse, followed by 3 pairs of bracket-type pulses EMER — As above but without X pulse
SUB PULSE SELECT Switch 4S2	Determines which pulse in the pulse train is to be removed and replaced by a substitute pulse
LEVEL Switch 4S3	Selects high or low amplitude level of the pulse train output at the VARI OUTPUT (variable output) connector
SUB PULSE POS Control 4L27	Varies position of the substitute pulse
PULSE WIDTH Control 4R49	Varies width of pulses in the pulse train
AMPLITUDE Control 4R91	Adjusts amplitude of pulses at VARI OUTPUT receptacle within range setting of LEVEL switch
INTERLEAVE Control 4R148	A variable resistor concentric with FUNCTION switch. Varies position of second (delayed) pulse train following normal train in interleaved signal

TABLE 3-7. RADAR TEST SET TS-1253A/UP CONTROLS AND INDICATORS

NAME	FUNCTION
POWER Switch	Two position toggle switch, turns power on and off for TS-1253A
POWER ON light	Indicates TS-1253A/UP power is on
Fuse Indicators	Two self-indicating fuses. When the neon bulb is lit, it indicates that fuse is blown

TABLE 3-8. CALIBRATION-CONTROL UNIT CONTROLS AND INDICATORS

NAME	FUNCTION
METER SELECT Switch 9S3	Four-position rotary switch, concentric with WM SENS control. Determines meter function to be used. Positions marked as shown below: CAL — In this position, the calibration signal level is adjusted for a full scale meter indication by means of the CAL ADJ control WM — In this position, the meter shows the wavemeter voltage, giving a dip as an indication of the resonance point 5000 PRF — In this position, the prf counting circuit is switched in and the meter is calibrated to indicate 5000 pps full scale 500 PRF — In this position, the prf counting circuit is switched in and the meter is calibrated to indcate 500 pps full scale
WM SENS Control 9RS1	Controls gain of wavemeter indicator amplifier
VIDEO OUT Switch 9S2	Ten-position rotary switch. Positions marked as shown below:

TABLE 3-8. CALIBRATION-CONTROL UNIT CONTROLS AND INDICATORS (Cont.)

NAME	FUNCTION
VIDEO OUT Switch 9S2	50 - In this position the calibration pulse at the VIDEO OUT connector has a 50-volt amplitude 10 - Same as above, but 10 volts 5 - Same as above, but 5 volts 2 - Same as above, but 2 volts 1 - Same as above, but 1 volt .5 Same as above, but 0.5 volt .1 Same as above, but 0.1 volt POWER - In this position, peak pulse amplitude of the video signal from the demodulator is available for power measurement on the oscilloscope SHAPE - In this position, video with minimum distortion is available for waveshape observation SG MON - In this position, a small portion of the rf signal from the demodulator is made available at the VIDEO OUT connector for monitoring

TABLE 3-8. CALIBRATION-CONTROL UNIT CONTROLS AND INDICATORS (Cont.)

NAME	FUNCTION
CAL ADJ (FULL SCALE) Control 9R45	Adjusts meter current for full scale needle deflection when reading calibration pulse amplitude
TRIGGER Selector 9S1	Three position rotary switch. Positions marked as shown below: DEMOD - In this position, the output of the demodulator is fed to the pulse counting circuits INT - In this position, the internally generated trigger pulses are counted EXT - In this position, external pulses for the TRIGGER INPUT connector are counted, (using a patch connection)
METER 9M1	Indicator for wavemeter resonance, prf counting, and pulse calibration

TABLE 3-9.
INTERROGATION CODER CONTROLS

NAME	FUNCTION
Function Selector 12S4	Seven-position rotary switch, concentric with VIDEO LEVEL control. Determines type of signal to be used as modulation and to appear at CODER OUT connector. Positions marked as shown below:

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
Function Selector 12S4 (Cont.)	MOD-HIGH - In this position, high level external video signals (20 to 35v) fed into the MOD connector, are applied to the modulator for modulating the rf signal
	MOD-LOW - In this position, low level external video signals (3 to 20v) fed into the MOD connector, are applied to the modulator for modulating the rf signal
	MOD-INT - In this position, an internally generated video signal is applied to the modulator for modulating the rf signal
	MOD-MIX - In this position, a mixed internal and external video signal (including code and mode identification pulses) is applied to the modulator for modulating the rf signal
	TEST - In this position, the same video signal as in MOD MIX position is made available at CODER OUT connector for monitoring and test purposes
	(+) - In this position, the modulating signal is removed from the modulator and is made available in a positive polarity at the

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
Function Selector 12S4 (Cont.)	CODER OUT connector
	(-) - In this position, the modulating signal is removed from the modulator and is made available in a negative polarity at the CODER OUT connector
VIDEO LEVEL Control 12R11	Adjusts level of video signal selected by the Function Selector
Mode Selector 12S5	Five-position rotary switch, concentric with CODE LEVEL control. Positions marked as shown below:
	SYNC M4 - In this position, a series of 4 pulses is internally supplied for use at the beginning of an interrogation train supplied from an external source (up to 37 pulses total). The pulses are 0.5 ± 0.1 usec wide and spaced 2 ± 0.1 usec apart
	1 - In this position, a mode 1 interrogation signal is generated consisting of two pulses which are variable in width from 0.35 to 1.3 usec and in spacing (by substitution) from 2.3 ± 0.05 to 3.7 ± 0.05 usec (normally 3.0 usec)
	2 - In this position, a mode 2 interrogation signal is generated consisting of two

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
Mode Selector 12S5 (Cont.)	pulses which are variable in width from 0.35 to 1.3 usec and in spacing (by substitution) from 4.3 ± 0.05 to 5.7 ± 0.05 usec (normally 5.0 usec)
	3 - In this position, a mode 3/A interrogation signal is generated consisting of two pulses which are variable in width from 0.35 to 1.3 usec and in spacing (by substitution) from 7.3 ± 0.05 to 8.7 ± 0.05 usec (normally 8.0 usec)
	C - In this position, a Mode C interrogation signal is generated consisting of two pulses which are variable in width from 0.35 to 1.3 usec and in spacing (by substitution) from 20.3 ± 0.05 to 21.7 ± 0.05 usec (normally 21.0 usec)
CODE LEVEL Control 12R12	Adjusts the level of interrogation pulses selected by Mode Selector
Substitute Pulse Selector 12S6	Nine-position rotary switch, concentric with CODE WIDTH control. Positions marked as shown below:
	RESET (1) - In this position, the second reset tag pulse is removed and a variable position pulse substituted for it

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
Substitute Pulse Selector 12S6 (Cont.)	RESET (2) - In this position, the third reset tag pulse is removed and a variable position pulse substituted for it
	M4 SYNC (1)- In this position, the second Mode 4 synchronizing pulse is removed and a variable-position pulse substituted for it
	M4 SYNC (2)- In this position, the third Mode 4 synchronizing pulse is removed and a variable-position pulse substituted for it
	M4 SYNC (3)- In this position, the fourth Mode 4 synchronizing pulse is removed and a variable-position pulse substituted for it
	M4 8 usec - In this position, the 8 usec ISLS pulse (when inserted by the ISLS Selector) is removed and a variable-position pulse substituted for it
	P3 - In this position, the third (last) pulse in the IFF/SIF interrogation is removed and a variable-position pulse substituted for it
	P2 - In this position, the second (ISLS) pulse in the IFF/SIF interrogation is removed and a variable-position pulse substituted for it

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
Substitute Pulse Selector 12S6 (Cont.)	OUT - In this position, no substitute pulses are used
CODE WIDTH Control 12R5	Adjusts width of all pulses in IFF/SIF code train
SUB PULSE Position Control 12L1	Variable drive coil on substitute pulse delay line 12DL1; enables continuous variation ± 3.5 usec from normal position for substitute pulses. Detented at 0, ± .2, and ± .7 positions
ISLS Selector 12S7	Six-position rotary switch, concentric with ISLS WIDTH control. Positions marked as shown below:
	OUT - In this position, no ISLS pulse is used
	EXT - In this position, a trigger signal (3 to 35v) fed into the ISLS connector from an external source is a applied to the ISLS oscillator, producing an ISLS pulse (P2) 2 ± 0.05 usec after the first Mark X interrogation pulse (P1)
	CHECK - In this position, the ISLS pulse generator is triggered in coincidence with the first pulse (P1) of the Mark X interrogation. This condition is used for checking the frequency of the variable rf oscillator (1030 mHz) by zero-beating with the signal from the precision ISLS oscillator
	2 usec - In this position, the ISLS pulse (P2) is triggered 2 ± 0.05 microseconds after the first interrogation pulse (P1). This is the normal position for the

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
ISLS Selector 12S7 (Cont.)	pulse when using the three-pulse ISLS system
	2 PULSE- In this position, the ISLS pulse (P2) replaces the last interrogation pulse (P3) forming the two-pulse ISLS pattern
	8 usec - In this position, (used for Mode 4 only) an ISLS pulse is triggered 8 ± 0.05 usec after the first mode 4 synchronizing pulse
ISLS WIDTH Control 12R7	Adjusts the width of the ISLS pulse from 0.5 to 1 usec
ISLS LEVEL Control	Adjusts the power of the rf ISLS pulse from approximately 1.5 db above the variable signal generator level to a value 12 db below it
VIDEO Selector 12S8	Three-position rotary switch. Positions marked as shown below:
	CODE - In this position, only the normal interrogation pulses are present in the output
	RESET - In this position, only the three reset tag pulses (undelayed) are present in the output
	BOTH - In this position, the interrogation pulses are present for use as mode identification tags (when combined with the SIF Coder output). The reset tag pulses, delayed 20 ± 2 usec after last pulse of coder output, are also present (to be put into place after the SIF pulse train)

TABLE 3-9. INTERROGATION CODER CONTROLS (Cont.)

NAME	FUNCTION
TRIG Connector Terminating Switch (75Ω) 12S2	Two-position toggle switch. In the 75Ω position, the TRIG connector is terminated in 75 ohms
ISLS Connector Terminating Switch (75Ω) 12S3	Two-position toggle switch. In the 75Ω position, the ISLS connector is terminated in 75 ohms
MOD Connector Terminating Switch (75Ω) 12S1	Two-position toggle switch. In the 75Ω position, the MOD connector is terminated in 75 ohms

TABLE 3-10. CODER SIMULATOR SM-197A/UPM-98 FRONT PANEL CONTROLS AND INDICATORS

NAME	FUNCTION
ATTENUATION Control 8 MP4	Adjusts amplitude of rf signal generator output.
SG FREQUENCY Control 8 MP5	Adjusts frequency of rf signal generator output.
WAVEMETER INPUT Switch 8S1	Three-position rotary switch. Selects either signal generator or demodulator output for application to the wavemeter (or "OFF" condition).
WAVEMETER FREQUENCY Control 8 MP3	Adjusts wavemeter resonance frequency for signal frequency measurement.
POWER Switch	Turns power for the SM-197A/UPM-98 on and off.
POWER ON light	When lit, indicates power is applied to SM-197A/UPM-98.
Fuse Indicators	When lit, indicate the associated fuse is open.

(2) DURING USE.

(a) OSCILLOSCOPE.- To operate the oscilloscope in the Display unit, proceed as follows:

Step 1. Rotate INTEN control on Display unit clockwise until the trace is visible.

Step 2. Adjust FOCUS AND ASTIG controls on Display unit for sharpest and most even trace.

Step 3. Set the SWEEP SPEED RANGE and ADJUST controls on the Sweep and Intensity Mark unit for the desired horizontal sweep length.

Step 4. Set the VOLTS/IN switch on Display unit to required vertical sensitivity in volts per inch.

Step 5. Connect the signal to be displayed to VIDEO input connector on the Display unit, using Test Lead MX-2681/UP or a CG-530/U cable assembly.

Step 6. If intensity markers are required, set INTENSITY MARKS RANGE switch on the Sweep and Intensity Mark unit to desired position and adjust INTENSITY MARKS LEVEL control for desired marker amplitude.

Step 7. If crystal controlled markers are required, set SYNC SELECT switch on the Crystal Mark and Sync unit to either INT 1.45 or INT 1.00 and adjust the XTAL MARK LEVEL control for proper marker amplitude.

(b) TRIGGER AND SUPPRESSOR PULSE APPLICATION.

1. SUPPRESSOR PULSE APPLICATION.- When it is necessary to suppress or gate the output of a radar transmitter or other equipment associated with the equipment under test, connect the SUP TRIGGERS connector on the Crystal Mark and Sync unit to the suppressor input connector on the external equipment, using CG-530B/U cable. The positive suppressor pulse is of an amplitude between 10 and 30 volts into a 500 ohm load or not less that 3 volts into a 75 ohm load. The pulse width can be adjusted from 2 to 220 microseconds by means of the SUP control.

2. EXTERNAL TRIGGERING OF TEST SET.- The test set may be triggered by an external synchronizing trigger signal having the following characteristics:

Pulse repetition frequency: 15 to 4100 pps
Pulse duration: 0.3 to 25 usec
Amplitude: 3 to 35 volts across 75 ohms
Rise time: less than 0.5 usec

If the equipment under test includes such a trigger signal output which is known to be working properly, trigger the test set as follows:

Step 1. Start and warm up both pieces of equipment.

Step 2. Connect trigger output from the equipment under test to the INPUT TRIGGER connector on the Crystal Mark and Sync unit, using a CG-530 B/U cable assembly.

Step 3. Set the SYNC SELECT switch on the crystal Mark and Sync unit to the EXT + or the EXT- position, depending upon the polarity of the input trigger.

3. INTERNAL TRIGGERING OF TEST SET.- When the equipment under test does not provide a trigger pulse, or the trigger source is not

operating properly, the test set can be triggered internally. In such cases, proceed as follows:

Step 1. Start test set.

Step 2. Set SYNC SELECT switch on the Crystal Mark and Sync unit to the INT, INT 1.45, or INT 1.00 position. When the switch is in the INT position, the test set is not synchronized with the markers; the sync pulse circuit is free-running and its pulse repetition frequency may be adjusted from 15 to 4100 pps by means of the PRF control. When the SYNC SELECT switch is in the INT 1.45 position, the internal sync pulse source is locked to the crystal-controlled 1.45 usec (689 kHz) markers. In the INT 1.00 position the sync pulse source is locked to the crystal controlled 1.00 usec (1 mHz) markers. In both cases the prf at the "0" trigger connector is variable between 15 and 4100 pps.by the PRF control.

Step 3. To find the approximate pulse repetition frequency of internal or external trigger pulse signals, use the pulse counter as described in paragraph 3-5k.

4. UNDELAYED TRIGGERING OF EXTERNAL EQUIPMENT.

Step 1. Trigger the test set as described above.

Step 2. Connect the external equipment to be triggered to the 0 TRIGGERS connector using CG-530B/U cable assembly. The trigger pulse supplied at this connector must be of positive polarity, with a fixed duration of approximately 2 microseconds, an amplitude of 50 to 100 volts into a 500 ohm load paralleled with 175 pf, or not less than 20 volts into 75 ohms paralleled with 1100 pf, and having a rise time of 0.2 microseconds. The pulse must be delayed not more than 0.25 microsecond from the leading edge of an external trigger pulse at the INPUT TRIGGERS connector.

5. DELAYED TRIGGERING OF EXTERNAL EQUIPMENT.

Step 1. Trigger test set as described in paragraph 3-4b (2) (b) 3 or 4 above.

Step 2. Set TRIGGER DELAY RANGE switch to a range position which includes the desired delay time.

Step 3. Adjust TRIGGER DELAY FINE and COARSE controls for the desired delay. The COARSE control can set the trigger delay to within approximately 1.0 microsecond of the desired delay. The FINE control can adjust the delay to within 0.05 microsecond by using the calibration markers.

Step 4. Connect the equipment to be triggered to the DELAYED TRIGGERS connector using CG-530B/U cable. The trigger pulse obtained from this connector will have the characteristics described in step 2 of paragraph 3-4 b (2) (b) 4.

(3) AFTER USE.- After completion of tests using Radar Test Set AN/UPM-98A, place POWER switches on both Radar Test Set TS-1253A/UP and Coder Simulator SM-197A/UPM-98 in OFF position. Disconnect all the interconnecting cables between the radar test set and the equipment under test.

(4) SECURING THE TEST SET.- After completing test using Radar Test Set AN/UPM-98A and disconnecting the interconnecting cables between the test set and the equipment under test secure the test set as follows:

Step 1. Disconnect and remove all external video and rf interconnecting cables from the test set and place them in Accessories Case CY-2725/UPM-98.

Step 2. Remove all connector adapters, if any were used. Place them in proper stowage locations in Accessories Case.

Step 3. Remove Test Lead MX-2681/UP and Cathode Ray Tube Visor MX-2953/UPM, if they were used, and place them in proper compartments in the Accessories Case.

Step 4. Close Accessories Case and store it together with Radar Test Set AN/UPM-98A for future use.

c. PRECAUTIONS.

(1) GENERAL.-Damage to either the test unit or the equipment being tested may result from improper use. Usually, damage is caused by application of input signals with excessive peak amplitudes or by application of signals having excessively high duty cycles.

(2) DUTY CYCLE LIMITATIONS.- Care must be taken not to apply signals having excessive duty cycles (pulse duty factors) to either the equipment under test or to the test equipment. When the 0 or DELAYED output trigger pulses are used to trigger external equipment, determine the duty cycle limitation of the external equipment, and calculate the duty cycle of the test set output signals from the formula given below. Adherence to this precaution will prevent damage to pulse-modulated microwave circuits and decoder circuits. Usually the duty cycle limit of this type of equipment is about 2 percent.

To calculate the duty cycle (pulse duty factor) of a pulse signal, it is necessary to determine the ratio of the "on" time to the total time

period under consideration. When the pulses are of equal widths, the number of pulses in each prf period (N) is multiplied by the pulse width (D) to obtain the "on" time for each prf period. The "on" time figure is multiplied by the prf figure (equivalent to dividing by its reciprocal, the prf period) and the result is multiplied by 100 to obtain the duty cycle figure in percent.

Duty Cycle in % = N x D x F x 100

Where: N=number of pulses per prf period
D=pulse duration in seconds
F=pulse repetition frequency (basic prf of system)

When pulses having different widths from the normal are present in the train, the widths of these pulses should be separately summed and added to the ND product in the above formula.

The SIF Coder is designed to safely handle signals of any duty cycle normally applied to it from the Crystal Mark and Sync unit. However, when the SIF Coder is triggered from an external source, the duty cycle might be greater. Using the formula above, calculate the duty cycle of the external signal. It should not exceed 6 percent. As a general rule, avoid input trigger signals having prf in excess of 4100 pps because of the associated high pulse duty factors.

(3) RADIO FREQUENCY POWER LIMITATIONS. - Do not apply radio frequency power in excess of 35 watts peak (continuous average of 0.25 watt) to the LP IN connector and do not apply power in excess of 3500 watts peak (continuous average of 5 watts) to the HP IN connector. Signals having ten watts average power may be applied to the HP IN connector for periods up to 5 minutes when not repeated more frequently than every 15 minutes.

(4) TEST LEAD MX-2681/UP LIMITATIONS AND CHARACTERISTICS. - The characteristics of the Test Lead MX-2681/UP are listed in Table 3-11.

TABLE 3-11.
TEST LEAD MX-2681/UP CHARACTERISTICS

ATTEN RATIO	INPUT CAPACITANCE	USEFUL RANGE (pulse amplitude)	SAFE OPERATION LIMITS (Peak ampl)
1:1	—	up to 50 v	50 v
10:1	20 pf	25 to 500 v	500 v
100:1	5 pf	250 to 5000 v	5000 v

(5) USE OF CABLES. - Two types of interconnecting cables are provided for use with the test set. Type CG-409E/U is used for carrying radio frequency energy and has a nominal characteristic impedance of 53.5 ohms. Type CG-530B/U is video frequency cable having a nominal characteristic impedance of 93 ohms. The CG-530 B/U cables should not be used for patching radio frequency signals, since impedance mismatch will result in standing waves and power loss with ensuing errors in measurements.

WARNING

There are dangerous voltages (up to 3000 volts ac) and a high vacuum associated with the cathode ray tube. Exercise care to prevent tube breakage and to avoid injury from electric shock.

(6) CATHODE RAY TUBE PRECAUTIONS. - Avoid the use of excessive intensity on the cathode ray tube display, especially when operating for extended periods of time, or when the Sweep and Intensity Mark unit is not being triggered and the trace is not swept horizontally on the screen. Make a practice of reducing the trace intensity whenever the oscilloscope is not used to prevent screen damage in case the horizontal sweep function should fail.

CAUTION

Always turn the INT control fully counterclockwise, cutting off the electron beam, when the Display unit is removed from the main frame and the sweeps are disabled. An intense electron beam concentrated on a small area will burn a permanent spot in the screen.

3-5. SUMMARY OF OPERATING PROCEDURES.

a. GENERAL. - The following is a short summary of operating instructions for Radar Test Set AN/UPM-98A. If additional information is required, refer to the detailed operating and test procedures in paragraphs 3-4 and 3-7.

b. STARTING THE EQUIPMENT.

Step 1. Connect the test set to a power source.

Step 2. Place POWER switches on both TS-1253A/UP and SM-197A/UPM-98 in ON position.

c. OSCILLOSCOPE OPERATING ADJUSTMENTS.

Step 1. Rotate INTEN control clockwise until trace is visible.

Step 2. Adjust FOCUS and ASTIG (astigmatism) controls for sharpest, most even trace.

Step 3. Set SWEEP SPEED RANGE and ADJUST controls for desired horizontal sweep duration.

Step 4. Set VOLTS/IN switch to required vertical sensitivity in volts per inch.

Step 5. Feed video signal to be displayed into VIDEO input connector using Test Lead MX-2681/UP or CG-530/U cable.

Step 6. If intensity markers are required, set INTENSITY MARKS RANGE switch to desired position and

adjust INTENSITY MARKS LEVEL control for proper marker display.

Step 7. If crystal markers are required, set SYNC SELECT switch to either INT 1.45 or INT 1.00 and adjust XTAL MARK LEVEL control for proper marker amplitude.

d. SWEEP DELAY ADJUSTMENT.

Step 1. Set SWEEP DELAY RANGE switch to range position covering the desired delay time. (Ranges are given in microseconds.)

Step 2. For sweep delay ranges 1-11, 11-21, and 21-31, adjust the SWEEP DELAY FINE control for proper delay.

Step 3. For sweep delay ranges 5-50 and 50-750, adjust both the SWEEP DELAY COARSE control and the SWEEP DELAY FINE control for proper delay.

e. TRIGGER DELAY ADJUSTMENT

Step 1. To delay the trigger at the DELAYED TRIGGERS connector, set TRIGGER DELAY RANGE switch to range position covering the desired delay time. (Ranges are given in microseconds.)

Step 2. For trigger delay range 1-11, adjust the TRIGGER DELAY FINE control for proper delay. For trigger delay ranges 5-50 and 50-750, adjust both the TRIGGER DELAY COARSE control and the TRIGGER DELAY FINE control for proper delay.

NOTE

To temporarily return the delayed sweep or trigger to zero time, momentarily hold the DELAY STROBE TRIGGER or SWEEP switch as applicable in its spring-loaded position. This will cause a pip-type marker to be also displayed on the trace at the spot where the delayed sweep or trigger will occur.

f. SIF CODER OPERATING ADJUSTMENTS.

Step 1. Connect zero triggers, delayed triggers, or external triggers to TRIGGER INPUT connector.

Step 2. Set FUNCTION and CODE selectors for required pulse train.

Step 3. Set LEVEL switch to LO or HI output as required.

Step 4. Connect output video from either MOD or VARI OUTPUT connector to equipment under test.

NOTE

Video level at VARI OUTPUT connector is continuously variable by means of AMPLITUDE control. Width of the pulses is variable by means of PULSE WIDTH control.

Step 5. If desired, use SUB PULSE SELECT switch to remove (one at a time) any pulse in the train except the start and ID pulses and to substitute a pulse which can be separately positioned by means of the SUB PULSE POS control.

Step 6. If interleaved code pulse train is desired, set FUNCTION switch in I position and adjust delay of the interleaved train as desired with INTERLEAVE control.

g. INTERROGATION CODER OPERATING ADJUSTMENTS.

Step 1. Connect zero triggers, delayed triggers, or external triggers to TRIG connector on the Interrogation Coder.

Step 2. Set Mode Selector switch for required type of output.

Step 3. Place Function Selector switch in (+) or (-) position to obtain desired polarity of output at CODER OUT connector. Set output amplitude by means of CODE LEVEL control and VIDEO LEVEL control.

Step 4. If the ISLS pulse is not desired, set ISLS Selector in OUT position. If three-pulse ISLS is to be simulated, set ISLS Selector in 2 usec position. If two-pulse ISLS is to be simulated, set ISLS Selector in 2 PULSE position. If an externally generated ISLS pulse is to be inserted, set ISLS Selector to EXT and connect external source to ISLS connector. Adjust amplitude of ISLS pulse with ISLS Level control and adjust width with ISLS width control.

Step 5. If a video output is desired, place Function Selector in (+) or (-) position. If the Interrogation Coder output is to be used to modulate the rf output, set Function Selector to MOD-INT position.

NOTE

The amplitude of the video output at CODER OUT connector is continuously variable by means of the CODE LEVEL and VIDEO LEVEL controls.

Step 6. If desired, select substitute pulse with Substitute Pulse Selector switch and use SUB PULSE position control to vary the position of the substitute pulse. Use CODE WIDTH control to vary the width of the output code pulses.

Step 7. If desired to modulate Interrogation Coder with SIF Coder output, connect SIF Coder TRIGGER INPUT to OUT connector on Interrogation Coder; connect SIF Coder MOD DRIVE to MOD connector on Interrogation Coder. Set Interrogation Coder function switch to MOD-MIX.

Step 8. If reset pulses are desired, set VIDEO switch on Interrogation Coder to RESET.

Step 9. If both mode identification pulses and reset tag pulses are desired, set VIDEO switch on Interrogation Coder to BOTH.

h. RF SIGNAL GENERATOR OPERATING ADJUSTMENTS.

Step 1. Apply modulation signal internally from Interrogation Coder by placing Function Selector switch in MOD-INT position or apply modulation signal from an external source by connecting source to MOD connector, and placing Function Selector switch in MOD-HIGH or MOD-LOW position as applicable.

Step 2. Set SG FREQUENCY dial to required frequency by using applicable graph in Book of Calibration Charts.

Step 3. Set ATTENUATION indicator to proper signal output level.

Step 4. Connect pulsed rf signal from SG OUT connector to equipment under test using CG-409E/U cable.

i. WAVEMETER OPERATING ADJUSTMENTS.

Step 1. Place METER SELECT switch in WM position and set WM SENS control to center of range.

Step 2. To measure frequency of external rf: Signals up to 35 watts in power should be connected to LP IN connector, and signals from 35 to 3500 watts to HP in connector. Terminate the connector not in use with the attached dummy load plug. Place WAVEMETER INPUT switch in DEMOD position. To measure frequency of internally generated rf: Place WAVEMETER INPUT switch in SIG GEN position.

Step 3. Turn WAVEMETER FREQUENCY knob until the meter dips, indicating resonance.

NOTE

To locate precisely the position of maximum needle deflection, it may be necessary to readjust the WM SENS control.

Step 4. Read the wavemeter frequency and determine the actual signal frequency from Book of Calibration Charts.

j. DEMODULATOR OPERATING ADJUSTMENTS.

Step 1. Connect external rf signal as in step 2 of Wavemeter Operating Adjustments above.

Step 2. Place VIDEO OUT switch on the Calibration-Control unit in the POWER position to measure the rf signal on oscilloscope, or in the SHAPE position to obtain a signal with less waveshape distortion for waveform observation on the oscilloscope.

Step 3. Connect CG-530/U cable from the VIDEO OUT connector on Calibration-Control unit to the VIDEO input connector on the Display unit.

Step 4. Adjust oscilloscope as in paragraph 3-5c.

k. PULSE COUNTING.

Step 1. Set METER SELECT switch to 5000 PRF.

Step 2. Set trigger switch to INT to count internally generated trigger pulses, to DEMOD to count pulses from the demodulator, or to EXT (using a patch connection) to count external signal pulses at INPUT connector.

Step 3. Read prf directly in pps from meter. If prf is below 500 pps, set METER SELECT switch to 500 PRF and read again.

l. SETTING UP CALIBRATION PULSES.

Step 1. Place METER SELECT switch in CAL position.

Step 2. Place VIDEO OUT switch in the desired CAL PULSE position to obtain a pulse having a precisely measured amplitude for calibrating purposes.

Step 3. Adjust CAL ADJ control for full clockwise deflection of meter needle.

Step 4. Connect calibrated pulse signal from VIDEO OUT connector on Calibration-Control unit to equipment under test.

m. TURNING OFF THE EQUIPMENT.- To turn off the radar test set, place POWER switches on both Radar Test Set TS-1253A/UP and Coder Simulator SM-197A/UPM-98 in OFF positions.

n. SECURING THE EQUIPMENT.- After using the radar test set, make certain that all the accessories supplied in the Accessories Case are removed from the test set front panel and the equipment under test are returned to the Accessories Case for future use.

3-6. EMERGENCY OPERATION

a. GENERAL.- Radar Test Set AN/UPM-98A consists of the following functional sections which may be operated independently under certain

conditions and with the proper modifications:

(1) Oscilloscope (Display Unit)
(2) SIF Coder
(3) Interrogation Coder
(4) Rf Signal Generator
(5) Wavemeter
(6) Demodulator
(7) Pulse Counter
(8) Calibrated Pulse Generator

All of the above sections are capable of independent operation in case of emergency, provided the applicable power supply circuits located in the rear of each drawer chassis are in operable condition and connected to the circuits and proper triggering signals are provided.

b. OPERATION WITHOUT INTERNAL TRIGGERS.- If the internal circuitry for generating either the free-running or the crystal controlled triggers is not functioning properly, the rest of the radar test set can be operated in most cases by supplying a proper external trigger pulse to the INPUT TRIGGERS connector on the Crystal Mark and Sync unit (see paragraph 3-7b (2) (b) (3)).

c. OPERATION WITH DEFECTIVE OSCILLOSCOPE.- If the oscilloscope circuitry contained in the Display Unit, the Sweep and Intensity Mark unit, and the Crystal Mark and Sync unit of TS-1253A is not functioning properly, it can be substituted with a standard oscilloscope of similar capability, using a common triggering signal source for both pieces of equipment.

3-7. TEST PROCEDURES.

a. PULSE MEASUREMENTS.

(1) GENERAL.- The Display Unit, the Sweep and Intensity Mark unit, and the Crystal Mark and Sync unit of Radar Test Set TS-1253A/UP together comprise a precision oscilloscope on which the horizontal sweep may be delayed with respect to the internal or external trigger pulse to permit viewing any part of a pulse or pulse train. Measurements of pulse characteristics can be made by following the procedures given below.

(2) SWEEP AND TRIGGER DELAY APPLICATION.- When it is desired to delay the start of horizontal sweep with respect to the synchronizing trigger pulse, proceed as follows:

Step 1. Set SWEEP DELAY RANGE control switch to a range position including the desired sweep delay; adjust SWEEP DELAY COARSE and FINE controls for the amount of delay required. (Rotating controls clockwise will cause the display to move to the left.) In this manner, a single pulse in a train or part of a pulse can be displayed.

Step 2. To view the leading edge of a pulse, the trigger should be delayed with respect to the sweep by means of the TRIGGER DELAY controls. To view the trailing edge of the pulse, the sweep should be delayed with respect to the trigger by means of the SWEEP DELAY controls. Any portion of a pulse or pulse train can be observed by gradually delaying trigger or sweep signal until the portion of interest comes into view.

(3) DELAY STROBE APPLICATIONS.- When switching to shorter duration sweeps to display a segment of a pulse or pulse train, it is difficult to locate the exact portion of the display desired by use of delay controls alone. Two DELAY STROBE switches provide a convenient means of locating the portion of the display to be viewed with delayed sweep or trigger. When either of the DELAY STROBE switches is pushed down to the spring-loaded position, the beginning of the horizontal sweep will return to zero time. At the same time, a marker pip will appear on the display, indicating the position of the delayed trigger or delayed sweep start as set by TRIGGER DELAY or SWEEP DELAY controls.

To obtain an expanded view of a part of the display by means of delayed sweep, proceed as follows:

Step 1. Hold DELAY STROBE SWEEP switch down.
Step 2. Adjust SWEEP DELAY RANGE switch and COARSE and FINE controls until marker pip appears under the leading edge of that portion of display to be expanded.
Step 3. Release DELAY STROBE SWEEP switch.
Step 4. Turn SWEEP SPEED RANGE switch and ADJUST control to sweeps of shorter duration to provide expansion of the pattern desired.
Step 5. A slight readjustment of SWEEP DELAY FINE control may be necessary to center the pattern properly on the screen.

To obtain an expanded view of part of the display employing delayed triggers, proceed as follows:

Step 1. Hold DELAY STROBE TRIGGER switch down.
Step 2. Adjust TRIGGER DELAY, COARSE and FINE controls until marker pip appears under the leading edge of the portion of the display to be expanded.
Step 3. Release DELAY STROBE TRIGGER switch.
Step 4. Turn SWEEP SPEED RANGE switch and ADJUST control to sweeps of shorter duration to provide the expansion of the pattern desired.
Step 5. A slight readjustment of TRIGGER DELAY FINE control may be necessary to center the image properly on the screen.

(4) INTENSITY MARKERS.- To superimpose intensity-type time marks (calibrated at time intervals of 0.1, 0.1 and 1, 1, 5, and 50

microseconds) on the horizontal trace for the purpose of measuring displayed waveforms, proceed as follows:

NOTE

In the .1 and 1 position, markers will be spaced at both 0.1 and 1 microsecond intervals. The 1-microsecond markers are wider for easy identification.

Step 1. Place INTENSITY MARKERS RANGE switch in the position which provides the desired marker spacing.

Step 2. Adjust brightness of the 1, 5, or 50 microsecond markers as desired with INTENSITY MARK LEVEL control.

NOTE

The 0.1-microsecond markers are not affected by the INTENSITY MARKS LEVEL control.

(5) USE OF CRYSTAL MARKERS.- Crystal-controlled video marker pulses are displayed when the test unit is triggered from the internal crystal oscillator with the SYNC SELECT switch in either the INT 1.45 or the INT 1.00 position. The 1-microsecond crystal-controlled markers can be used to check interrogation pulse spacing for the interrogation coder or external source. The 1.45 microsecond markers are provided mainly for checking and calibrating spacing of SIF reply pulse trains from the SIF Coder or from an external source. Turn the XTAL MARK LEVEL control clockwise until markers of the desired amplitude can be seen on the display trace.

(6) SIGNAL TRACING.- The Test Lead MX-2681/UP is supplied with the test set for signal tracing It has a built-in attenuator providing three attenuation ratios: 1:1, 10:1 and 100:1. Whenever possible, use the 100:1 attenuation, since this probe impedance causes the least loading of the circuit under test. When the amplitude of the signal to be checked is low (less than approximately 2 volts), it will be necessary to use the 1:1 or 10:1 attenuation ratio.

CAUTION

Do not use the probe attenuation ratio of 1:1 where voltages in the circuit under test are over 500 volts dc. Do not use the 10:1 attenuation ratio in circuits where the voltage is over 1000 vdc. Do not use the video probe on circuits where voltages exceed 5000 volts dc. Do not use the video probe on circuits carrying radio-frequency energy.

NOTE

When using the video probe for pulse amplitude measurements, be certain that the 75Ω switch on the Display unit is in the OUT position, otherwise voltage amplitude indications will not be in accordance with the calibrated settings of the VOLTS/IN switch.

(7) PULSE AMPLITUDE.- To measure amplitude of a video pulse, proceed as follows:

Step 1. Start test set.

Step 2. Trigger test set.

Step 3. Feed video pulse signal to be measured into VIDEO input connector on the Display unit. If pulse signal comes from a high-impedance source, leave 75Ω switch in OUT position. If the pulse signal comes from a low impedance source, set 75Ω switch to IN position. If the signal is picked up through the video probe (test lead), set the 75Ω switch to the OUT position.

Step 4. Adjust SWEEP SPEED and SWEEP DELAY controls for suitable pulse width.

Step 5. Adjust SCALE control until calibration lines are clearly visible.

Step 6. Adjust HOR and VERT controls until bottom of pulse to be measured is aligned with the vertical scale calibration line so that scale divisions can be easily counted.

Step 7. Adjust VOLTS/IN switch to set display pulse amplitude to between one and two inches. Note setting of the VOLTS/IN switch and use the calibrated scale markings to measure amplitude of pulse. Be certain that VIDEO SENS control is in CAL position (fully clockwise).

NOTE

Do not set video probe attenuation to 100:1 for display of signal pulses having durations over approximately 2 usec. In this setting the probe provides only capacitive coupling and longer pulses will be distorted.

(8) PULSE DELAY.- Procedures for measuring the delay between two signal pulses are given below. When the first pulse is coincident with the trigger pulse, proceed as follows:

Step 1. Start test set.

Step 2. Trigger equipment under test using no time delays, as described in paragraph 3-4b (2) (b) 5.

Step 3. Connect delayed pulse to VIDEO input connector on Display unit.

Step 4. Adjust SWEEP SPEED and SWEEP DELAY controls for a convenient view of the delayed pulse, and note its position.

Step 5. Depress DELAY STROBE SWEEP switch and adjust the SWEEP

DELAY control to put the sweep delay trigger pulse in the position formerly occupied by the second (delayed) pulse. Use intensity markers to measure time delay of the sweep delay trigger pulse. This is the time delay of the second pulse.

When the first and the second pulses are both delayed from the trigger pulse, separately measure the time delay of each pulse from the trigger using a method similar to that outlined above. The difference between the two delays will give the delay from the first pulse to the second pulse.

(9) PULSE DURATION. - To determine the time duration (width) of a pulse, proceed as follows:

Step 1. Display the pulse on the oscilloscope, using the SWEEP SPEED RANGE switch and the SWEEP SPEED ADJUST control to set the pulse width to a convenient size.

Step 2. Adjust the SWEEP DELAY controls to center the pulse on the screen.

Step 3. Turn the INTENSITY MARKS RANGE switch to the position which superimposes upon the pulse pattern a number of intensity-type time markers having a suitable spacing. (Greatest accuracy will be obtained from the 1 and 0.1 microsecond markers.)

Step 4. Count the number of time intervals marked off between the leading and trailing edges of the pulse. (Standard measurement is between 50% amplitude points on both leading and trailing edges.)

Step 5. Multiply the number of time increments by the length of an increment (INTENSITY MARKS RANGE switch setting) to obtain pulse width.

(10) OVERSHOOT. - Measure the amplitude from the base line of the trace to the peak of the overshoot point as described in paragraph 3-7a (8) and measure the duration of the overshoot interval as described in paragraph 3-7a(9) above.

(11) PULSE TOP DETERIORATION. - The characteristics of the pulse top, including its deterioration, can be measured by the methods described in paragraphs 3-7a(8) and 3-7a(9) above. The pulse top is usually considered to be that part of a pulse above the points at 90% of full height on the leading and trailing edges.

(12) RISE AND DECAY TIME. - Rise and decay times are usually defined as the time required to go from 10% of full amplitude to 90% of full amplitude and from 90% of full amplitude to 10% of full amplitude, respectively. The measuring procedure is the same as the width measurement described in paragraph 3-7a(9). The vertical scale on the oscilloscope screen can be used as an aid in determining the 10% and 90% points.

(13) PULSE SPACING. - Pulse spacing measuring are made using the procedure for either duration or delay measurement as described in paragraph 3-7a(8) and 3-7a(9), respectively. Spacing is measured from a point on the leading edge of the first pulse to a corresponding point on the leading edge of the other pulse.

b. SIF CODER USE.

(1) GENERAL. - The general SIF pulse code pattern as generated by the SIF Coder is illustrated in figure 3-2 and described in paragraph 3-1 b (2). Simulated SIF codes (set up by the four CODE selectors) can be employed for signal tracing, modulating transmitters under test, and for decoder testing. They also can be used to modulate the rf oscillator in Coder Simulator SM-197A/UPM-98, the output of which in turn can be used to test and adjust receivers, decoders, or transponders.

(2) TRIGGERING. - The SIF Coder can be triggered by external equipment which delivers a positive pulse, or it can be triggered from the Crystal Mark and Sync unit by utilizing the output from the 0 TRIGGERS or DELAYED TRIGGERS connector. The trigger pulse signal is supplied to the TRIGGER INPUT connector on the SIF Coder through a CG-530B/U cable.

(3) PULSE TRAINS. - Five basic types of coded pulse trains can be set up on the SIF Coder. The type is selected by the FUNCTION switch. Table 3-12 gives the makeup of the pulse train for each position of the FUNCTION switch. A sixth FUNCTION switch position provides the combination of a normal and a slightly delayed pulse train to simulate interleaved code replies.

(4) PULSE TRAIN SETTING. - To set up any of the SIF pulse trains, proceed as follows:

Step 1. Start test set.

Step 2. Trigger equipment.

Step 3. Connect TRIGGER INPUT connector on SIF Coder and 0 TRIGGERS or DELAYED TRIGGERS connector on Crystal Mark and Sync unit as applicable, with CG-530B/U cable.

Step 4. Set the four CODE selectors to the desired code number.

Step 5. Connect VARI OUPUT connector and the VIDEO input connector (on the Display unit) with CG-530B/U cable.

Step 6. Adjust PRF control for the desired pulse repetition rate (between 15 and 4100 pps).

Step 7. Adjust SWEEP SPEED and SWEEP DELAY controls until the entire pulse train can be seen on the screen.

Step 8. Adjust AMPLITUDE control for desired pulse amplitude. Place LEVEL switch in HI position for for maximum output. Measure amplitude of the pulses using VOLTS/IN switch.

Step 9. Disconnect coaxial cable between VIDEO and VARI OUTPUT connectors. Video output pulse trains can now be used for test

TABLE 3-12. SIF CODER OUTPUTS

FUNCTION Selector Position	SIF CODER Output	Pulses Available (figure 3-2)
N	Framing pulses plus up to 12 information pulses	A, B, C, D
ID	Same as N plus ID pulse	A, B, C, D + ID
X	Same as N plus X pulse	A, B, C, D + X
EMER	One pulse group consisting of framing pulses and up to 12 information pulses followed by three empty pairs of bracket-type pulses with 4.35 microsecond spacing between pairs	A, B, C, D and three pairs of bracket-type pulses
EMER + X	Same as EMER plus X pulse	A, B, C, D + X (also 3 empty pairs of bracket-type pulses)
I	Each pulse train interleaved with another identical pulse train delayed as determined by the setting of the INTERLEAVE control	Same as normal train

purposes either directly from the VARI OUTPUT connector or (if the pulse train is to be employed to modulate the rf output signal) by "jumpering" the MOD DRIVE connector on the SIF Coder to the MOD connector on the Interrogation Coder.

(5) SUBSTITUTE PULSE FACILITY.- Any one of the twelve code pulses, the X pulse, or the last framing pulse may be removed from the train and substituted with a movable pulse. This substitute pulse can be shifted ± 1.6 microseconds from its original position. To use the substitute pulse feature, proceed as follows:

Step 1. Set SUB PULSE SELECT switch to a numbered position representing the pulse to be replaced.

Step 2. Adjust position of the substitute pulse with the SUB PULSE POS control.

(6) PULSE WIDTH ADJUSTMENT.- The width of the pulses in the pulse train can be adjusted from less than 0.3 to more than 1.0 microsecond by the PULSE WIDTH control. The control panel has a mark at the 0.45 microsecond position, which is the nominal pulse width.

c. INTERROGATION CODER USE.

(1) TRIGGERING.- The Interrogation Coder is triggered in the same manner as the SIF Coder (see paragraph 3-7b(2)). Set the TRIG terminating switch to 75Ω, if an external trigger of more than a 50 volts amplitude is used.

(2) FUNCTION SELECTOR SETTINGS.- The Function Selector determines the type of Interrogation Coder output to be used (see table 3-13).

(3) VIDEO OUTPUTS.- The basic pattern of the video output provided by the Interrogation Coder is determined by the setting of the Mode Selector. The width of the interrogation pulses is adjustable by the CODE WIDTH control. The ISLS Selector determines the type of ISLS pulse to be combined with the basic interrogation pattern if such is desired. The width of the ISLS pulse is adjusted by the ISLS WIDTH control and the amplitude of the ISLS pulse is determined by the ISLS LEVEL control. The Substitute Pulse Selector permits substitution of a variable-position pulse for (a) the second interrogation pulse or in the ISLS pulse in M-1, M-2 or M-3/A interrogations, (b) for the second, third, or fourth Mode 4 sync pulses, or (c) for the second or third reset tag pulses. An externally generated ISLS trigger can be employed by applying it to the ISLS input connector and setting the ISLS Selector to the EXT position.

(4) MODULATION BY EXTERNAL SIGNAL.- Modulation of the rf signal generator from an external source can be accomplished by connecting the signal to the MOD connector and setting the Function Selector to the MOD-HIGH or MOD-LOW position. Setting the Function Selector to MOD-MIX allows output modulation by external high level pulses as well as the internally generated pulses.

(5) EXTERNAL SIGNAL GENERATOR MODULATION.- To obtain the Interogation Coder

TABLE 3-13.
INTERROGATION CODER FUNCTIONS

Function Selector Setting	Application
(+)	Makes available at CODER OUT connector a positive-going signal (without ISLS) selected by Mode Selector. No rf output.
(-)	Same as (+) except that a negative-going signal is made available at CODER OUT connector.
MOD-MIX	Internally mixes internal code and external modulation signals for application to rf signal generator as a modulating signal.
TEST	Same as MOD-MIX except it makes available at CODER OUT connector the same signal which was internally switched in MOD-MIX position.
MOD-INT	Connects output signal selected by Mode Selector so as to modulate the rf output of the signal generator. Code pulse width adjusted by CODE WIDTH control.
MOD-LOW	Internally connects MOD connector to rf signal generator for modulating its output. For use with modulating signals 3 to 20 volts in amplitude. Pulse width is externally controlled.
MOD-HIGH	Same as MOD-LOW except for use with modulating signals 20 to 35 volts in amplitude.

video output for modulation of an external rf signal generator, proceed as follows:

Step 1. Connect CODER OUT connector on Interrogation Coder to modulation input of the external signal generator.

Step 2. Place Function Selector in (+) or (-) position, as desired.

Step 3. Adjust CODE LEVEL control for required pulse amplitude. The VIDEO LEVEL control adjusts the amplitude of all the output pulses at the CODER OUT connector.

(6) MODE IDENTIFICATION PULSE OUTPUT.- Mode identification video is obtained by combining the interrogation signal with the composite SIF reply video as a means for identifying the mode. To obtain mode identification video, proceed as follows:

Step 1. Set VIDEO selector to BOTH position.

Step 2. Connect output of triggering source to TRIG connector.

Step 3. Connect OUT connector to TRIGGER INPUT on SIF Coder.

Step 4. Connect MOD DRIVE on SIF Coder to MOD input connector on Interrogation Coder.

Step 5. Set Function Selector on Interrogation Coder to MOD-MIX position. The SIF Code pattern selected on the SIF Coder will be preceded by the tags consisting of the original interrogation pulses. This composite signal will modulate the rf generator. If it is desired to have it appear at the CODER OUT connector, place the Function Selector in the TEST position.

(7) RESET TAGS.- Reset tag pulses are added to the above composite signal to simulate the reset signal occurring at the end of the reply. Reset tags may be produced either with or without the mode identification pulses. To obtain reset tag pulses, proceed as follows:

Step 1. Set up as for mode identification pulses above.

Step 2. For reset tag pulses alone, set VIDEO selector to RESET position. For reset tag pulses and mode identification pulses combined, set selector to BOTH position. Three reset tag pulses of different widths will follow the SIF train.

d. RF SIGNAL GENERATOR USES.

(1) RF OUTPUT SIGNAL LEVEL ADJUSTMENT.- The level of the pulsed rf output at the SG OUT connector is adjusted by means of the ATTENUATION control and is read on the associated counter dial. The output level at the SG OUT connector, when terminated by a 53.5 ohm load, can be read directly from the dial in decibels below one volt.

When the SG OUT and SG IN connectors are jumpered together with the CG-1848/U rf cable, the output of the rf signal generator is available at the LP IN and HP IN connectors through additional attenuation. To find the exact amount of attenuation for a particular test set, refer to the Demodulator Calibration Curves in the Book of Calibration Charts supplied with each test set. The approximate attenuation from the LP IN connector to the HP IN connector is 20 db. The total attenuation from the SG IN connector to the HP IN connector is approximately 33 db. If either the LP IN or the HP IN connector is used, the other connector should be terminated with the dummy load plug 8P15, attached near the connector on the front panel.

NOTE

When more accurate measurments are required, compensate for the inherent attenuation in the coaxial cable used between the test set and the external equipment. The

loss in RG-62/U rf cable at the frequencies used in this test set is approximately 17 db per 100 feet.

(2) RF OUTPUT SIGNAL FREQUENCY SETTING. - The frequency of the signal generator is set by means of the WAVEMETER FREQUENCY and SG FREQUENCY controls. The procedure for making this setting is as follows:

Step 1. Provide either internal or external modulation input to the signal generator.
Step 2. Set the desired frequency on the WAVEMETER FREQUENCY dial, using the curves in Book of Calibration Charts provided with each test set.
Step 3. Place the METER SELECT switch on the Calibration-Control unit in the WM position.
Step 4. Set the WM SENS control on the Calibration-Control unit fully clockwise for maximum sensitivity.
Step 5. Place the WAVEMETER INPUT switch in the SIG GEN position and adjust the SG FREQUENCY control until the needle dips, indicating resonance. In order to determine the exact point of needle deflection, it may be necessary to readjust the WM SENS control. When the resonance point has been located, the signal generator frequency has been set.

(3) RF OUTPUT SIGNAL MODULATION. -

(a) MODULATION OF RF OUTPUT SIGNAL BY INTERROGATION CODER. - To modulate the rf signal output with the Interrogation Coder, proceed as follows:

Step 1. Connect the trigger source to the TRIG connector on the Interrogation Coder, using CG-530B/U cable.

NOTE

One of three different trigger sources may be used:

(1) 0 TRIGGERS output from the Crystal Mark and Sync Unit.
(2) DELAYED TRIGGERS output from the Crystal Mark and Sync Unit.
(3) An external trigger source.

Step 2. Place the Function Selector on the Interrogation Coder in the INT position.
Step 3. Set the Mode Selector for the mode of interrogation to be simulated. Adjust the CODE WIDTH control for desired pulse width.
Step 4. Set frequency and power level of the rf signal as described in paragraphs 3-7d (1) and 3-7d (2) above.

(b) MODULATION OF RF OUTPUT SIGNAL BY SIF CODER. - To modulate the rf signal output with the SIF Coder, proceed as follows:

Step 1. Trigger the SIF Coder as described in paragraph 3-7b(2).
Step 2. Jumper the MOD DRIVE connector to the MOD connector on the Interrogation Coder using CG-530B/U coaxial cable.
Step 3. Place Function Selector on the Interrogation Coder in MOD-HIGH position.
Step 4. Place LEVEL switch (on the SIF Coder) in HI position.
Step 5. Set SIF Coder for required pulse train.
Step 6. Set the rf signal frequency and power level as described in paragraphs 3-7d (1) and 3-7d (2).

(c) MODULATION OF RF OUTPUT SIGNAL BY EXTERNAL SIGNALS. - To modulate the rf signal with an external pulsed signal, proceed as follows:

Step 1. Using CG-530 B/U cable assembly, connect MOD connector on the Interrogation Coder to an external signal source delivering from 3 to 55 volt positive pulses into a 120 ohm impedance.
Step 2. Place Function Selector in MOD-LOW position if level of the external signal is below 20 volts, or in MOD-HIGH position if the level is from 20 to 35 volts.
Step 3. Set power level and frequency of the rf signal as described in paragraphs 3-7d (1) and 3-7d (2).

(4) TESTING RECEIVERS AND DECODERS. - To test IFF/SIF interrogator receivers with associated decoders or transponders using the pulse-modulated rf signal, proceed as follows:

Step 1. Start and warm up equipment.
Step 2. Jumper SG OUT connector to SG IN connector using cable assembly CG-1848/U, and connect rf input of the equipment under test to HP IN connector on Coder Simulator SM-197A/UPM using cable assembly CG-409 E/U.
Step 3. Connect either Interrogation Coder or SIF Coder as described in paragraph 3-7d (3) (c).
Step 4. Set power level and frequency of the signal as described in paragraph 3-7d (1) and 3-7d (2).
Step 5. Observe response of the equipment under test on the oscilloscope. The particular response required for acceptance will depend upon the nature and setting of decoder under test.

(5) TESTING ISLS CAPABILITY OF TRANSPONDERS. - To test the performance of the side lobe suppression circuits of an IFF transponder, proceed as follows:

Step 1. Connect the transponder under test and Radar Test Set

AN/UPM-98A as outlined in the applicable test instructions in the technical manual for the transponder. Interrogate the transponder in any mode and observe the replies from it.

Step 2. Set Substitute Pulse Selector to OUT position. Set ISLS Selector to 2 usec position. Turn ISLS Level control fully clockwise. The transponder should stop replying.

Step 3. Turn ISLS Level control slowly counter-clockwise. Up to the 0 mark (at which point the simulated ISLS reference signal amplitude is equal to the amplitude of the simulated interrogation signal) the transponder should not reply, since the interrogation signal amplitude is well below the reference signal, indicating it is from a side lobe rather than the main lobe of the sending antenna.

Step 4. Continue turning the ISLS Level control slowly counter-clockwise. Between the 0 mark and the -9 db mark (which indicates that the ISLS reference signal is 9 db below the interrogation signal), the transponder may or may not reply, depending upon a number of variable factors.

Step 5. Continue turning the ISLS Level control slowly counter-clockwise. Beyond the -9 db mark the transponder should reply continuously since the amplitude of the interrogation signal is well above that of the ISLS reference signal, indicating it is the signal from the main lobe of the sending antenna and not from a side lobe.

Step 6. Turn the ISLS Level control in the reverse direction. As the control is turned clockwise the transponder should behave as described above in each of the three zones of the control.

(6) RECEIVER FREQUENCY SETTING.- To set the frequency of a receiver under test, proceed as follows:

Step 1. Start and warm up equipment.

Step 2. Set desired rf output power level and frequency as desired in paragraph 3-7d. Be sure that power level is low enough to prevent saturation of the receiver under test.

Step 3. Connect SG OUT connector on the signal generator to antenna input of the equipment under test, using CG-409E/U cable assembly.

Step 4. Connect the demodulated (video) output of the receiver under test to the VIDEO input connector on the Display unit.

Step 5. Tune receiver under test so that maximum amplitude pulse appears on the oscilloscope screen. (See paragraph 3-7a.) Reduce gain of the receiver, when necessary, to produce convenient pattern size. When the receiver is tuned to give maximum pattern height on oscilloscope, it is tuned to the signal generator frequency.

(7) RECEIVER BANDWIDTH MEASUREMENT.- To measure the bandwidth of a receiver under test, proceed as follows:

Step 1. Start and warm up equipment.

Step 2. Set signal generator to the desired output level and the given receiver operating frequency as described in paragraph 3-7. The output level must be low enough to prevent receiver saturation.

Step 3. Connect SG OUT connector on the signal generator to the appropriate input of the receiver under test, using CG-409E/U cable assembly.

Step 4. Measure the amplitude of the signal at the video output of the receiver under test, using the oscilloscope (see paragraph 3-7a).

Step 5. Note setting on the ATTENUATION dial and decrease the amount of attenuation by 6 db. This will increase the rf output level by 6 db.

Step 6. Adjust SG FREQUENCY control on the signal generator to one side of center frequency until video output voltage reading on the oscilloscope is equivalent in amplitude to the original center frequency reading in step 4 above. (This is the "6 db down" point). Note the frequency at this point.

Step 7. Repeat step 6 on the other side of center frequency.

Step 8. The difference between the two frequencies obtained in steps 6 and 7 is the bandwidth of the receiver at the -6 db points for the given operating frequency.

(8) RECEIVER SENSITIVITY MEASUREMENT.- To measure the tangential sensitivity of a receiver under test, proceed as follows:

Step 1. Start and warm up both pieces of equipment.

Step 2. Set signal generator frequency to the receiver operating frequency as described in paragraph 3-7d.

Step 3. Connect SG OUT connector on the signal generator to the appropriate input of the receiver under test, using the CG-409E/U cable assembly.

Step 4. Observe the output of circuit under test on the oscilloscope (see paragraph 3-7a).

Step 5. Adjust ATTENUATION control on the signal generator until height of receiver output signal as observed on the oscilloscope is twice that of the noise signal appearing with it. Read ATTENUATION indicator to obtain tangential sensitivity in db below 1 volt.

NOTE

Readings on the signal generator ATTENUATION dial will be accurate only if receiver under test presents the proper 53.5 ohm load impedance to the signal generator.

e. WAVEMETER USES.-

(1) FREQUENCY MEASUREMENT OF EXTERNAL PULSED RF SIGNALS.- To measure frequency of an external pulsed rf signal, proceed as follows:

Step 1. Start and warm up equipment

Step 2. Feed the external rf signal into the LP IN connector on Coder Simulator SM-197A/UPM-98 if power level is less than 35 watts, or into the HP IN connector if power level is between 35 and 3500 watts. In either case, terminate the unused connector with a dummy load plug 8P15.

Step 3. Place METER SELECT switch on the Calibration-Control unit in WM position.

Step 4. Adjust WM SENS control until meter shows maximum deflection.

Step 5. Adjust WAVEMETER FREQUENCY control until meter needle dips, indicating resonance. To determine exact point of maximum needle deflection, it may be necessary to readjust WM SENS control to a higher setting.

Step 6. When resonance point has been located, note reading on the WAVEMETER FREQUENCY dial. Determine the frequency corresponding to this dial reading by using curves in Book of Calibration Charts, provided with each test unit.

(2) FREQUENCY MEASUREMENT OF INTERNAL RF SIGNAL.- To measure frequency of internal rf signal, proceed as follows:

Step 1. Place METER SELECT switch on Calibration-Control unit in WM position.

Step 2. Adjust WM SENS control until meter shows maximum needle deflection.

Step 3. Place WAVEMETER INPUT switch in SIG GEN position and adjust WAVEMETER FREQUENCY control until meter needle dips, indicating resonance. To determine exact point of maximum needle deflection, it may be necessary to readjust WM SENS control to a higher setting.

Step 4. When resonance point has been located, note reading on the WAVEMETER FREQUENCY dial. Determine the frequency corresponding to this dial reading by using curves in Book of Calibration Charts provided with each test unit.

f. DEMODULATOR USES.

(1) TRANSMITTER POWER MEASUREMENTS.- To measure the output power of a transmitter under test, proceed as follows:

Step 1. Start and warm up equipment.

Step 2. Feed the transmitter output to the HP IN connector on Coder Simulator SM-197A/UPM-98. Terminate the LP IN connector with the 8P15 dummy load plug.

Step 3. Place VIDEO OUT switch on Calibration-Control unit in POWER position.

Step 4. Jumper VIDEO OUT connector on Calibration-Control unit to the VIDEO input connector on the Display unit.

Step 5. Turn VIDEO SENS control on Display unit to the extreme clockwise position.

Step 6. Place VOLTS/IN switch on Display unit in the position in which the pattern on the crt most nearly reaches full-scale amplitude.

NOTE

If no position of the VOLTS/IN switch gives a deflection of appreciable size on the crt, change the transmitter output connection to the LP IN connector and terminate the HP IN connector with the 8P15 dummy load plug.

Step 7. Measure the peak-to-peak pattern height in volts.

Step 8. Determine power level corresponding to this peak-to-peak height by using the correct demodulator calibration curve in Book of Calibration Charts provided with each test set. (There is one curve for the HP IN connection and another for the LP IN connection.)

(2) TRANSMITTER OUTPUT WAVEFORM TESTS.- To observe undistorted output waveforms on the oscilloscope, proceed as follows:

Step 1. Connect rf output of the transmitter under test to the test set as described in paragraph 3-7f(1).

Step 2. Place VIDEO OUT switch on the Calibration-Control unit in SHAPE position.

To measure characteristics of the demodulated transmitter output pulses observed on the Display unit, refer to procedures described in paragraph 3-7a.

(3) MONITORING WAVEFORM OF MODULATED RF SIGNAL. - The waveform of the modulation "envelope" on the signal generator output can be observed on the oscilloscope while rf power is being delivered to an external load. To make this observation, proceed as follows:

Step 1. Connect the SG OUT connector to the signal generator to the external load.

Step 2. Place the VIDEO OUT switch on the Calibration-Control unit in the SG MON (signal generator monitoring) position.

Step 3. Jumper the VIDEO OUT connector on the Calibration-Control unit to the VIDEO input connector on the Display unit.

Step 4. Adjust oscilloscope sweep to observe pulse.

g. PULSE COUNTER USE.

(1) GENERAL. - The test set is capable of measuring prf up to 5000 pps. A directly calibrated meter is provided for this purpose. Meter accuracy is 5% at full-scale indication and 10% at one-tenth of the scale. The TRIGGER switch on the Calibration-Control unit connects the pulse source to the counter circuits as shown in table 3-14.

NOTE

The pulse counter is so designed that it will directly indicate the prf of trigger pulse signals. If a normal SIF reply signal (up to 7777 with ID) is applied to the pulse counter, each pulse train will be counted as a single pulse.

(2) PROCEDURE. - To measure an unknown prf, proceed as follows:

Step 1. Place TRIGGER switch on Calibration-Control unit in the desired position (see table 3-14).

TABLE 3-14. PULSE COUNTER APPLICATIONS

TRIGGER Switch Positions	PULSES COUNTED
DEMOD	Demodulated rf (video) pulses.
INT	Delayed sync pulses from the Crystal Mark and Sync unit.
EXT	External pulses brought in through TRIGGER INPUT connector on the Calibration-Control unit.

Step 2. Place METER SELECT on Calibration-Control unit switch in 5000 PRF position.

Step 3. Note deflection of the meter needle and read meter directly in pps. If prf is read as less than 500 pps, turn METER SELECT switch to 500 PRF and read again.

h. USE OF VIDEO CALIBRATOR PULSES.

(1) PURPOSE. - Video calibrator pulses from 0.1 volt to 50 volts amplitude can be made available at VIDEO OUT connector on the Calibration-Control unit for troubleshooting and test purposes.

(2) PROCEDURE. - To obtain video calibrator pulse output, proceed as follows:

Step 1. Provide a trigger source in any one of the three ways described in paragraph 3-4b (2) (b).

Step 2. Place METER SELECT switch on Calibration-Control unit in CAL position.

Step 3. Turn VIDEO OUT switch on the Calibration-Control unit to the position providing the desired pulse amplitude.

Step 4. Feed the calibrated pulses from VIDEO OUT connector on the Calibration-Control unit to the proper input point on equipment under test using CG-530B/U coaxial cable.

Step 5. Adjust the CAL ADJ control on the Calibration-Control unit so that the meter shows full-scale needle deflection.

i. USE OF CALIBRATION CHARTS.

(1) GENERAL. - A Book of Calibration Charts is provided with each test set. This book contains calibration curves for the wavemeter, the demodulator, and the rf oscillator.

(2) USE OF WAVEMETER CALIBRATION CURVES. - To find the exact frequency for a particular setting of the wavemeter counter dial, proceed as follows:

Step 1. Note the WAVEMETER FREQUENCY dial reading.

Step 2. Refer to the wavemeter calibration curve which contains this reading.

Step 3. Read the frequency in megacycles (megahertz) from the calibration curve.

(3) USE OF DEMODULATOR CALIBRATION CURVES. - To find the power of an rf signal applied to the demodulator inputs, proceed as follows:

Step 1. Note the peak oscilloscope pattern height obtained for the power measurement described in paragraph 3-7f (1).

Step 2. Refer to either the LP IN or HP IN Demodulator Calibration Curve, depending upon which input connector is being used.

Step 3. Read the rf power input in db above 1 watt from the curve.

Step 4. Add of subtract from the reading obtained in step 3 the correction factor for the particular frequency being measured as shown in Correction Chart provided underneath the Demodulator Calibration Curve.

(4) USE OF OSCILLATOR CALIBRATION CURVE. - To set the variable rf oscillator to desired frequency with the SG FREQUENCY control, proceed as follows:

Step 1. On the Oscillator Calibration Curve, find the proper dial reading for the desired frequency.

Step 2. Set the SG FREQUENCY counter to the number obtained in step 1.

NOTE

The setting of a frequency from the Oscillator Calibration Curve will be only approximate. For a more accurate frequency check, follow the procedure described in paragraph 3-7i(2) using the proper Wavemeter Calibration Curve.

3-8. OPERATOR'S MAINTENANCE.

a. OPERATING CHECKS. - To establish that the Radar Test Set AN/UPM-98A is in full operational readiness, use operational check-out procedures outlined in paragraph 2-7 of this manual. These procedures are arranged to make possible a complete check-out of the test set using only the built-in test features. No additional test equipment is required to perform the checks. If any of the normal indications cannot be obtained, refer to the troubleshooting and maintenance procedures in section 4 and 5.

b. PREVENTIVE MAINTENANCE ROUTINES. - Preventive maintenance routes to be performed by the operator are described in Section 5.

c. EMERGENCY MAINTENANCE. -Radar Test Set AN/UPM-98A is a piece of complex test equipment for use chiefly by maintenance technicians during repair and testing of operational IFF equipment. Refer to Section 4, Troubleshooting, and Section 5, Maintenance, for instructions and precautions to be followed during maintenance and for illustrations showing locations of electron tubes, fuses, and assemblies.

(1) REPLACEMENT OF PLUG-IN UNITS.- In an emergency, when the trouble can be located in one of the plug-in units and a replacement unit is available, a complete plug-in unit may be replaced with a new unit. Refer to Section 5 for information regarding removal and exchange of these units.

TABLE 3-15. AN/UPM-98A SIGNAL CONNECTORS

Connector	Location	Function
VIDEO 1J1	Display Unit	BNC type UG-625B/U connector. Input point for video signal to be displayed on oscilloscope. Input impedance may be changed from 7 megohms to 75 ohms by means of 75Ω switch.
INPUT TRIGGERS 3J1	Crystal Mark and Sync Unit	BNC type UG-625B/U connector.
SUP TRIGGERS 3J2	Crystal Mark and Sync Unit	BNC type UG-625B/U connector. Impedance 470 ohms
0 TRIGGERS 3J3	Crystal Mark and Sync Unit	BNC type UG-625B/U connector. Impedance 500 ohms
DELAYED TRIGGERS 3J4	Crystal Mark and Sync Unit	BNC type UG-625B/U connector. Impedance 470 ohms
TRIGGER INPUT 4J1	SIF Coder	BNC type UG-625B/U connector.
MOD DRIVE 4J2	SIF Coder	BNC type UG-625B/U connector. Impedance 690 ohms
VARI OUTPUT 4J3	SIF Coder	BNC type UG-625B/U connector. Impedance varies from 250 ohms to 0 with setting of AMPLITUDE control. Main signal output point for SIF Coder. Output amplitude variable from 0 to 5 volts with LEVEL switch in LO position and from 7 to 35 volts with LEVEL switch in HI position.
SG OUT 8J6	SM-197A Panel	Type UG-291/U connector. Main output from rf oscillator section. Output variable by means of ATTENUATION control. When terminated in a 53.5 ohm load, the SG OUT level can be read directly from the attenuator dial in db below one volt. Can be jumpered to SG IN for further fixed attenuation.
SG IN 8J13	SM-197A Panel	Type UG-291/U connector. Impedance 75 ohms. Input point to demodulator circuit for rf oscillator signal. When jumpered to SG OUT connector, rf signal generator output becomes available at LP IN and HP IN connectors. Attenuation is determined from charts.
LP IN 8J14	SM-197A Panel	Type UG-291/U connector. Input point to demodulator circuit for low power (below 35 watts) external rf signals. Terminated with dummy load 8P15 when HP IN is used. Approximate attenuation from SG IN is 13 db.
HP IN 8J15	SM-197A Panel	Type UG-291/U connector. Input point to demodulator circuit for high power (35 to 3500 watts) external rf signals. Also used as rf output point when SG IN is jumpered to SG OUT. Terminated with dummy load 8P15 when LP IN is used. Approximate attenuation over LP IN is 20 db, from SG IN, 33 db
TRIGGER INPUT 9J2	Calibration-Control Unit	Type UG-625/U connector. Input point to Calibration-Control circuits for external trigger signal. Used when TRIGGER switch is in EXT position.
VIDEO OUT 9J3	Calibration-Control Unit	Type UG-625B/U connector. Main signal output for Calibration-Control circuits. Output type may be any one of ten selected by the VIDEO OUT switch: 50, 10, 5, 2, 1, .5, or .1 volt calibrating pulses, a pulse signal for power measuring purposes, a low distortion signal for waveform analysis, or a signal generator monitoring signal.

TABLE 3-15. AN/UPM-98A SIGNAL CONNECTORS (Cont.)

Connector	Location	Function
MODE 4 IN 9J9	Calibration-Control Unit	Type UG-625B/U connector. Input point to mode 4 reply decoding circuits.
MODE 4 OUT 9J10	Calibration-Control Unit	Type UG-625B/U connector. Output from mode 4 reply decoding circuits.
TRIG 12J1	Interrogation Coder	Type UG-625B/U connector. Input point to Interrogation Coder circuits for external trigger signal. Impedance may be changed from high to low (75 ohms) by means of terminating switch 12S2. 75 ohm position used for signals over 50 volts. Normally connected to 0 TRIGGERS or DELAYED TRIGGERS on Crystal Mark and Sync Unit or an external trigger source.
ISLS 12J2	Interrogation Coder	Type UG-625B/U connector. Input point to ISLS circuits for external ISLS trigger signal. Impedance may be changed from high to low (75 ohms) by means of terminating switch 12S3.
MOD 12J3	Interrogation Coder	Type UG-625B/U connector. Input point to interrogator modulator circuits for external modulating signals. Impedance may be changed from high to low (75 ohms) by means of terminating switch 12S1. Connected into circuit by Function Selector in MOD-LOW, MOD-HIGH, MOD-MIX, and TEST positions. Inputs from 3 to 20 volts accepted in MOD-LOW; from 20 to 35 volts in MOD-HIGH (source voltage rated into 120 ohms).
OUT 12J4	Interrogation Coder	Type UG-625B/U connector. Impedance 470 ohms. Output point for trigger signal delayed 40 usec from main trigger.
CODER OUT 12J5	Interrogation Coder	Type UG-625B/U connector. Impedance varies from 0 to 500 ohms with Video Level control. Output point for coder signals selected by function switch in TEST, (+), or (-) position. TEST signal consists of complete composite video signal. Signal on (-) is same as (+) but reversed in polarity.

SECTION 4

TROUBLESHOOTING

4-1. GENERAL.

This section contains troubleshooting procedures and tests for locating and correcting some of the troubles that may develop in the Radar Test Set AN/UPM-98A. To take advantage of the troubleshooting information presented herein, maintenance personnel should be thoroughly familiar with the installation, operation, and theory of operation of the equipment as described in this manual.

The troubleshooting procedures described in this section are intended to isolate a malfunction to a particular unit of the AN/UPM-98A, and then to isolate the malfunction to a particular section, stage, and element within the unit. When troubleshooting or repairing the AN/UPM-98A, personnel should refer to the overall schematic diagrams and to the simplified schematic diagrams and block diagrams. This section also contains a tabulation of all assemblies and subassemblies (for identification), a list of test points, and the associated voltages and waveshapes. Figure 4-1 is an overall block diagram of Radar Test Set AN/UPM-98A.

All possible troubles that may arise when operating the equipment cannot be described in this manual. Whenever a specific trouble is not covered, maintenance personnel should proceed to locate the defective component using the standard techniques of signal tracing and voltage and resistance checks, as outlined in NAVSHIPS 0967-000-0130 Handbook of Test Methods and Practices.

NOTE

Before proceeding with any troubleshooting procedures, check front panel controls of the equipment to make certain incorrect settings are not causing faulty operation.

4-2. LOGICAL TROUBLESHOOTING.

a. SYMPTOM RECOGNITION.- This is the first step in the troubleshooting procedure and is based on overall knowledge and understanding of operating characteristics of the equipment. Equipment troubles are not always the direct result of complete component failure; therefore, a trouble in an equipment may not always be easy to recognize since all conditions of less than peak performance are not always apparent. This type of equipment malfunction is usually discovered while accomplishing preventive maintenance procedures. It is important that the "not so apparent" troubles, as well as the apparent troubles, be recognized.

b. SYMPTOM ELABORATION.- After an equipment trouble has been recognized, all the available aids designed into the equipment should be used to further elaborate on the original trouble symptom. Use of front panel controls and other built-in indicating and testing aids should provide better identification of the original trouble symptom.

c. LISTING PROBABLE FAULTY FUNCTION.- The next step in logical troubleshooting is to formulate a number of "logical choices" as to the cause and likely location of the trouble. The "logical choices" are mental decisions which are based on knowledge of the equipment operation, a full identification of the trouble symptom, and information contained in this manual. The overall functional description and its associated block diagram should be referred to when selecting possible faulty functional sections.

d. LOCALIZING THE FAULTY FUNCTION.- For the greatest efficiency in localizing trouble, the functional sections which have been selected by the "logical choice" method should be tested in the order that will require the least time. This requires a mental selection to determine which section to test first. The selection should be based on the validity of the "Logical Choice" and the difficulties in making the necessary tests. If the tests do not prove that functional section to be at fault, the next selection should be tested, and so on until the faulty functional section is located. As aids in this process, the manual contains block diagrams for the various functional sections of the equipment. Waveforms (or other pertinent indications) are included for significant test points to aid in isolating the faulty section. Also, test data (such as information on control settings, critical adjustments, and required test equipment) is supplied.

e. LOCALIZING TROUBLE TO THE CIRCUIT.- After the faulty functional section has been isolated, it is necessary to make additional "logical choices" as to which circuit or group of circuits (within the functional section) is at fault. Block diagrams and schematic diagrams for the functional section and individual functional circuit groups (when required) provide the signal flow and test location information needed to bracket and then isolate the faulty circuit.

f. FAILURE ANALYSIS.- After the trouble (faulty part, misalignment, etc.) has been located (but prior to performing corrective action), the procedures followed up to this point should be reviewed to determine exactly why the fault affected the equipment in the manner that it did. This review is necessary to make certain that the fault discovered is actually the cause of the malfunction, and not just a result of the malfunction.

g. VOLTAGE AND RESISTANCE MEASUREMENT.- As an aid in troubleshooting, important

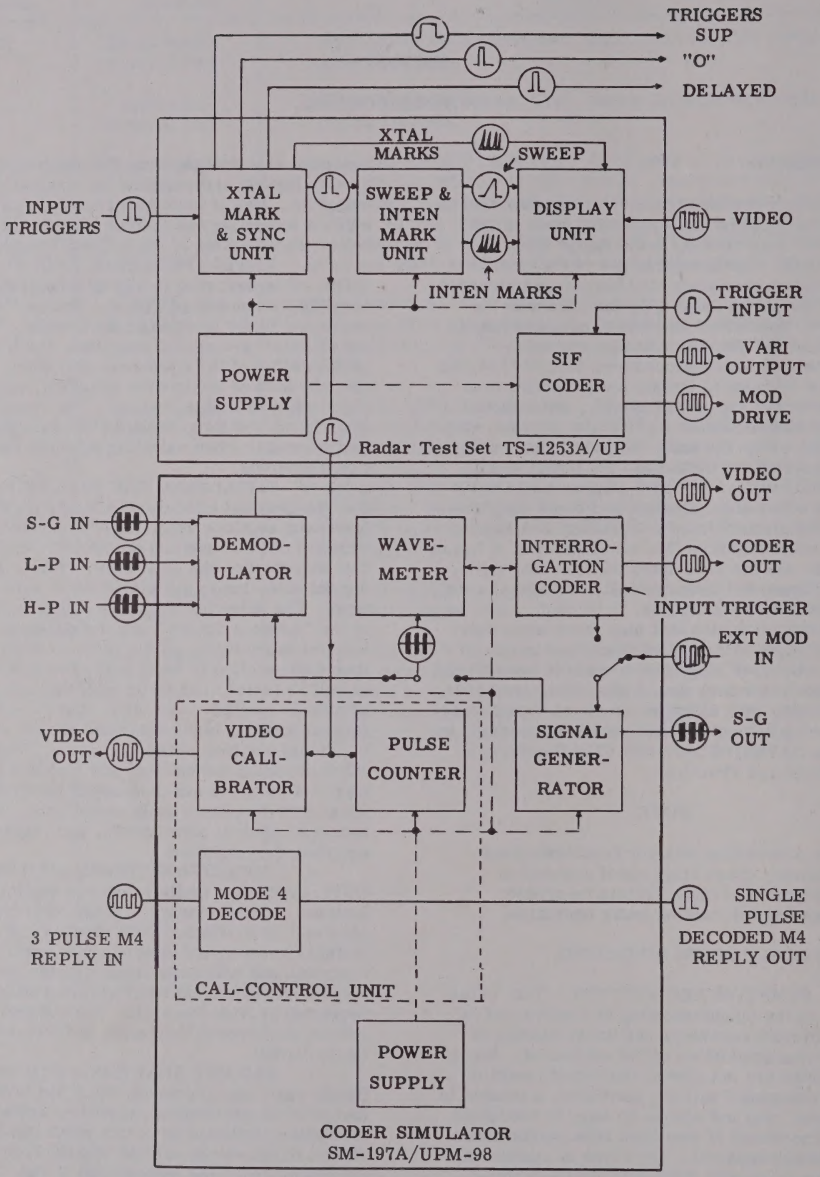


Figure 4-1. Radar Test Set AN/UPM-98A, Block Diagram

voltages are marked on the appropriate lines and terminals in the schematic diagrams. Correct resistances between most points in the circuits may be readily determined from the resistance values shown in the diagrams. More important waveforms and voltage and resistance measurements at the test points are included in the data for each functional section. Equipment required for testing the Radar Test Set is listed is table 1-7.

WARNING

At some points in this equipment, potentials exist which may cause death or serious injury upon contact. Maintenance personnel should exercise due caution when servicing the equipment.

4-3. OVERALL FUNCTIONAL DESCRIPTION.

Test Set AN/UPM-98A consists of two main functional sections as shown in figure 4-1. The test set combines several different test instruments into a single piece of equipment, therefore some individual functional sections of Radar Test Set AN/UPM-98A can be operated independently from each other for certain tasks.

The two main sections of the Test Set are identified as Radar Test Set, TS-1253A/UP (upper section) and Coder Simulator SM-197A/UPM-98 (lower section). Each of these two sections has its own power supply, but both are operated from a common ac power line. (See figure 5-67 for overall power distribution.)

4-4. CODER SIMULATOR SM-197A/UPM-98 FUNCTIONAL DESCRIPTION.

a. OVERALL DESCRIPTION.- The Coder Simulator provides pulses necessary for checking Mark X Coders and rf test facilities for checking secondary radar equipment. This unit consists of a panel-chassis assembly which includes the power supply, the main UHF assemblies, and the facilities for connecting the plug-in Calibration-Control unit and the plug-in Interrogation Coder.

The pulse generator and the counter circuits of the Calibration-Control unit use either external positive triggers or the delayed triggers supplied internally from Radar Test Set TS-1253A/UP. Voltage-calibrated "video" pulses are supplied at the VIDEO OUT connector on the Calibration-Control unit. The prf of either the external or internal triggers can be used on the panel meter. This unit also provides switching, control, and indicating functions for the panel-chassis assembly.

The SM-197A/UPM-98 panel-chassis assembly contains the power controls, the rectifier circuits and the regulator circuits for Coder-Simulator SM-197A/UPM-98. This chassis assembly has provisions for mounting and interconnecting the plug-in Calibration-Control and Interrogation Coder units. In addition, this assembly contains the main rf signal generator, the wavemeter, the attenuator, and the demodulator for use in rf tests and measurements.

b. CODER SIMULATOR SM-197A/UPM-98 TEST DATA.- Tables 4-5 and 4-6 give voltage and resistance measurements for Coder Simulator SM-197A/UPM-98. Other test data for the Coder Simulator is included in the data for the individual functional sections.

c. CODER SIMULATOR SM-197A/UPM-98 CIRCUIT DESCRIPTION.

(1) INTERROGATION CODER.- As shown in the block diagram, figure 4-2, the Interrogation Coder may be divided for discussion into two main functional sections: the coder section and the modulator section, with additional circuits for production of ISLS pulses, substitute pulses, and reset tag pulses. The coder section is capable of simulating interrogation signals in the several modes used in IFF/SIF systems. Waveforms are shown in figure 4-3 and voltage and resistance measurements are given in table 4-1.

The Interrogation Coder uses an externally generated positive trigger pulse to initiate the production of interrogation pulse pairs. Operator controls permit mode selection, video output amplitude adjustment, and output polarity selection. The Interrogation Coder panel switching also permits selection of the type of modulation signal to be fed to the rf signal generator; the Interrogation Coder output, or either low amplitude or high amplitude external signals. Panel connectors are provided for both external ISLS triggers and external code triggers, for an external modulation input, and for pulse signal output.

A miniature stripline directional coupler is used to combine the rf signals from the ISLS rf generator with those from the main (variable frequency) signal generator on the SM-197A chassis. Combining the signals in a directional coupler prevents loading of the signal generator, thereby preventing frequency and modulation "pulling" effects. The combined signals (consisting of pulses P1, P2, and P3) are passed through the attenuator and used as an interrogation signal with ISLS.

(a) CODER SECTION.- The coder section of the Interrogation Coder includes the circuits whose primary function is to produce pulse-train signals in the standard code patterns; timing, spacing, synchronizing, and repeating them as required. (See figure 4-4.)

NOTE

Modes 1, 2, 3/A, and C are referred to as "Standard" in this document; mode 4 is considered non-standard.

This is accomplished by means of a clock oscillator and associated triggering, gating, and recycling circuits (located in Clock and Line Drive Assembly 12A1) working in conjunction with Delay Line Assembly 12A2 and associated diode Matrix Assembly 12A3. Code pattern selection is essentially a matter of switching enabling voltages (by means of Mode Selector 12S5) onto the matrix diodes associated with the proper delay line taps.

1. CLOCK AND LINE DRIVE ASSEMBLY 12A1.- The main functions of this assembly are performed by circuits for timing and synchronizing the other Interrogation Coder functions, and circuits for repeating the coding cycle

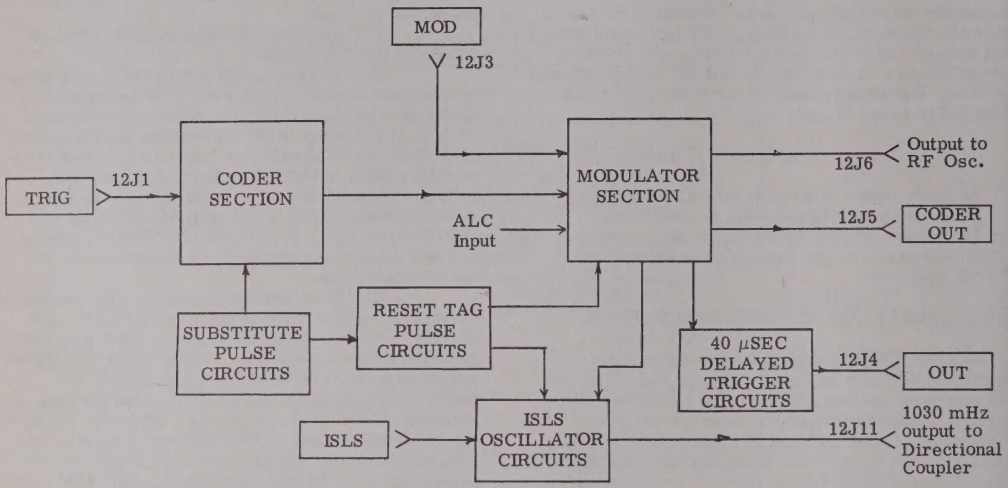


Figure 4-2. Interrogation Coder Overall Functional Block Diagram

TABLE 4-1. INTERROGATION CODER VOLTAGE AND RESISTANCE MEASUREMENTS

TEST POINTS	VOLTAGE MEASUREMENTS
12TP1 to ground	-30 vdc
12TP2 to ground	-12 vdc
12TP3 to ground	+12 vdc
12TP4 to ground	+25 vdc
12TP5 to ground	+300 vdc
Transformer 12T2 terminal 1 to 2	6.3 vac
Connector 12J7 pin S to ground	+25 vdc
Connector 12J7 pin 4 to ground	+12 vdc
Connector 12J7 pin 14 to ground	-12 vdc
Connector 12J9 pin B to ground	+25 vdc
Connector 12J9 pin 14 to ground	+12 vdc
Connector 12J9 pin 3 to ground	-12 vdc
Connector 12J10 pin 6 to ground	+300 vdc
Connector 12J10 pin 3 to ground	+25 vdc
Connector 12J10 pin 5 to ground	+12 vdc
Connector 12J10 pin 2 to ground	6.3 vac

TUBE	MEASUREMENTS – TUBE PIN TO GROUND								
	1	2	3	4	5	6	7	8	9
12V1	+43 v 1.2 mego	-0.02 v 5.8 k	0 0	0 ∞	Fil. v ∞	NC NC	+65 v ∞	NC NC	NC NC
12V2	-30 v 69 k	+43 v 1.2 mego	0 ∞	Fil. v ∞	+170 v ∞	NC NC	-30 v 14 k	-	-
12V3	+300 v 1 mego	-30 v 68 k	NC NC	0 ∞	Fil. v ∞	NC NC	+170 v 1 mego	-5 v 6.4 k	NC NC

NO	TEST POINT	WAVEFORM	REMARKS
1	12A1 TP1	1 usec/cm 5v/cm	
2	12A1 TP2	0.5 usec/cm 5v/cm	SUB PULSE switch at 2 usec
3	12A1 TP3	2 usec/cm 2v/cm	VIDEO switch at BOTH
4	12A1 TP4	0.5 usec/cm 10v/cm	
5	12A1 TP5	0.5 usec/cm 10v/cm	
6	12A2 TP1	2 usec/cm 5v/cm	
7	12A2 TP2	0.5 usec/cm 5v/cm	
8	12A6 TP1	5 usec/cm 5v/cm	VIDEO switch at RESET
9	12A6 TP2	20 usec/cm 5v/cm	VIDEO switch at BOTH
10	12A6 TP3	20 usec/cm 5v/cm	VIDEO switch at BOTH
11	12A6 TP4	1 usec/cm 5v/cm	ISLS switch at 2 usec
12	12A6 TP5	2 usec/cm 2v/cm	
13	12J5 (CODER OUT)	2 usec/cm 10v/cm	FUNCTION switch at TEST VIDEO switch at CODE ISLS switch at 2 usec LEVEL controls cw
14	12J6 -1	2 usec/cm 100v/cm	
15	12J6 -3	0.5 usec/cm 20v/cm	ISLS switch at 2 usec
16	12J4 (OUT)	0.5 usec/cm 10v/cm	VIDEO switch at BOTH

Figure 4-3. Interrogation Coder Waveforms

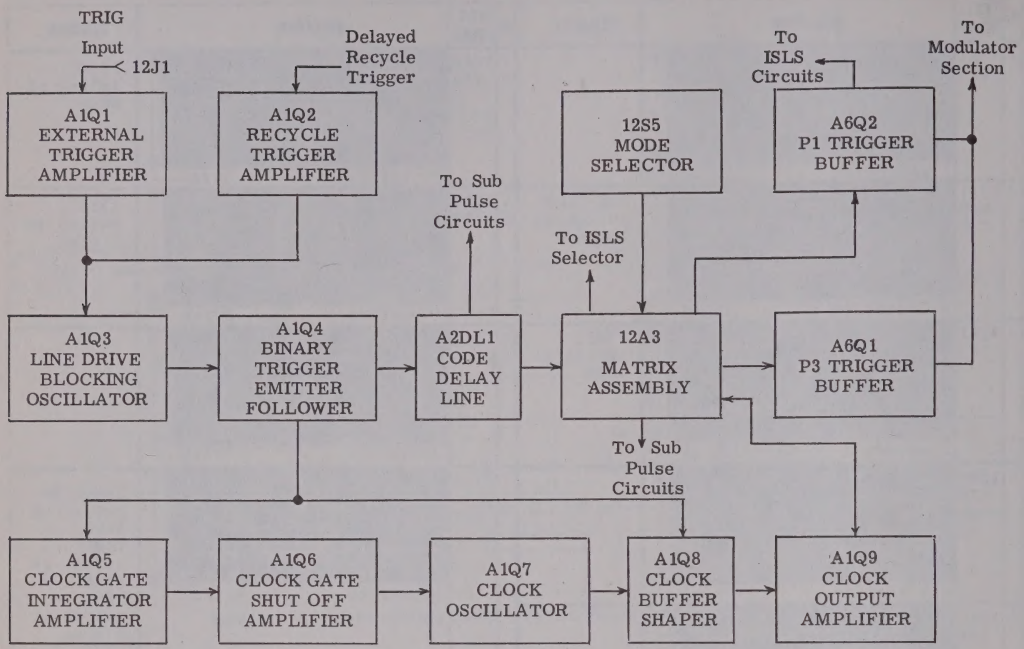


Figure 4-4. Interrogation Coder, Timing and Coding Circuit, Block Diagram

("recycling") as required. The assembly also includes circuits for processing trigger signals, for processing substitute pulses, for processing external modulation signals, and for mixing pulse signals.

The trigger signal required by these circuits is obtained from the signal source connected to TRIG connector 12J1 (figure 4-5). This positive signal may be supplied from a source external to the AN/UPM-98A Radar Test Set or from the Crystal Mark and Sync unit in the Radar Test Set. Connector 12J1 will present either a high impedance or a low (75 ohm) impedance, depending upon the position of terminating switch 12S2. The input trigger pulse signal is fed into Clock and Line Drive Assembly 12A1 through 12J7-7, then passed through capacitor 12A1C1 and clipping diode 12A1CR1. It is coupled through diode 12A1CR2 and capacitor 12A1C2 to external trigger amplifier 12A1Q1. The amplified output from 12A1Q1 is coupled through capacitor 12A1C3 to the primary of transformer 12A1T1, the secondary of which applies it to binary trigger input emitter follower 12A1Q4. The output of 12A1Q4 is fed to delay line (Code) 12A2DL1. At the same time, the output of 12A1Q4 is applied to clock gate integrator amplifier 12A1Q5 (figure 4-6) causing it to conduct. Capacitor 12A1C7 and resistor 12A1R7 in the collector circuit of 12A1Q5 perform an integrating function, determining the length of time gate shut-off amplifier 12A1Q6 will be cut off, and permitting clock oscillator 12A1Q7 to run. The operation of the clock oscillator circuits may be inhibited by a ground applied to the cathode of diode 12A1CR5. The output of 12A1Q7 is processed by clock buffer shaper 12A1Q8 and clock output amplifier 12A1Q9. The clock pulse signal is fed out of the 12A1 assembly through 12J7-A for distribution to the proper circuits.

The 12A1 assembly includes circuits for processing substitute pulses. Separate input channels are used for standard code pulse substitute triggers and for reset pulse substitute triggers (figure 4-7). Standard substitute triggers (2 usec early "reference" triggers from Matrix Assembly 12A3) are fed into the 12A1 assembly to the input of sub pulse reference emitter follower 12A1Q10.

ISLS pulse substitute reference triggers are fed to the same point. Reset tag pulse substitute triggers are fed in to the input of reset sub pulse emitter follower 12A1Q11. The output of either 12A1Q10 or 12A1Q11 is coupled through a diode (12CR10 or 12CR9) and through capacitor 12A1C13 to sub pulse trigger amplifier 12A1Q12. The output of 12A1Q12 is coupled through 12A1C14 and transformer 12A1T2 to sub pulse blocking oscillator 12A1Q13, the output of which is passed through sub pulse line drive emitter follower 12A1Q14 to the movable drive coil 12DL1 of sub pulse position delay line 12DL1 (4 usec). The delayed output of 12DL1 is returned to sub pulse emitter follower 12A1Q15. The output of 12A1Q15 is fed to sub pulse shaper 12A1Q16 and then to the junction of diodes 12A1CR17 and 12A1CR18. At this point the delayed sub pulse may

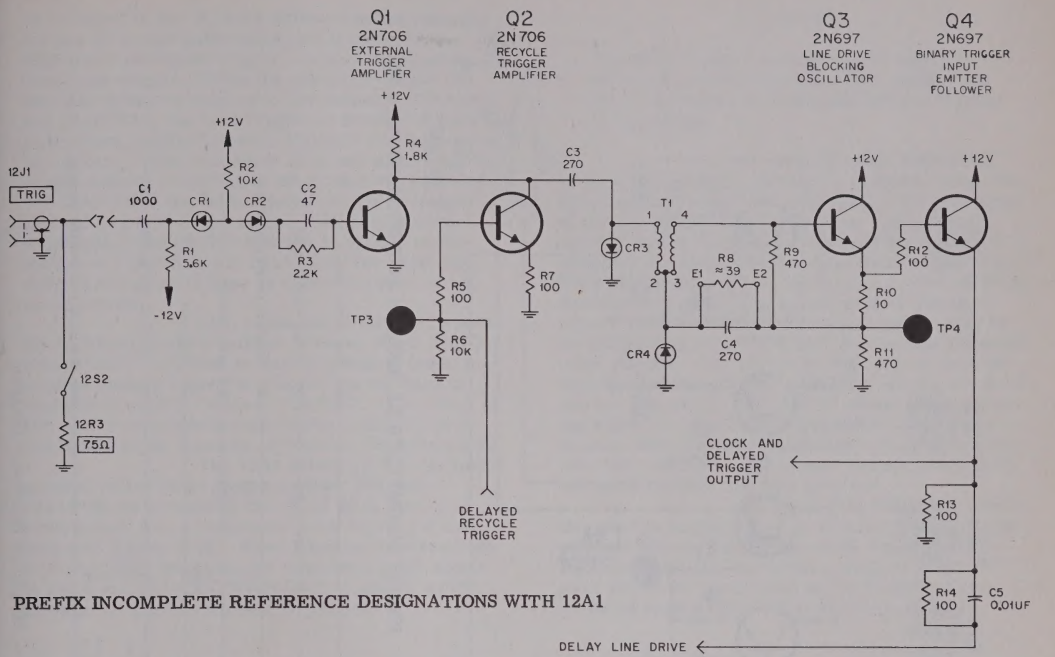


Figure 4-5. External Trigger and Recycle Circuits, Simplified Schematic Diagram

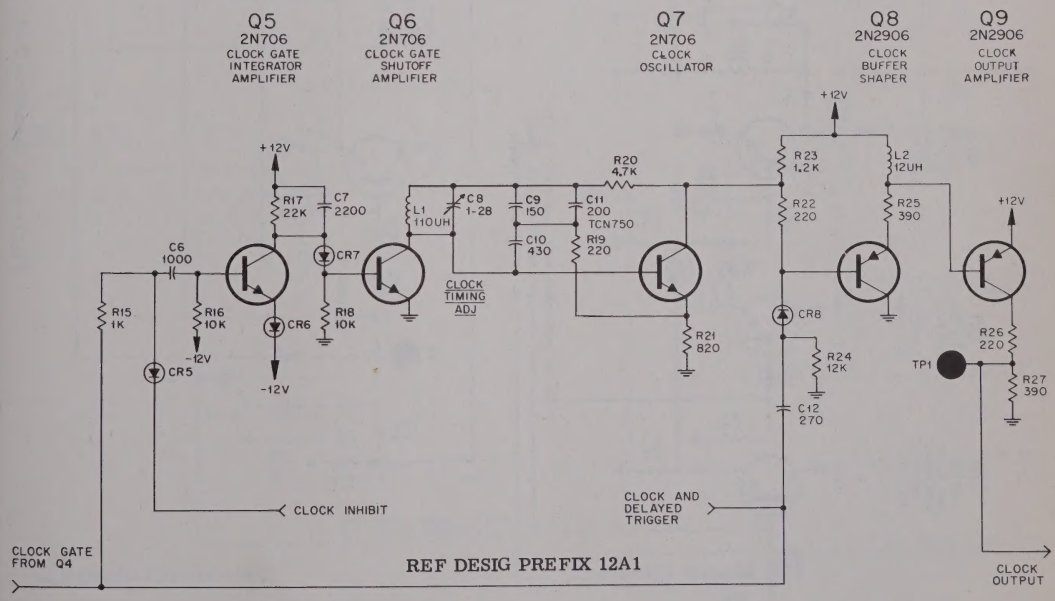


Figure 4-6. Clock Circuits, Simplified Schematic Diagrams

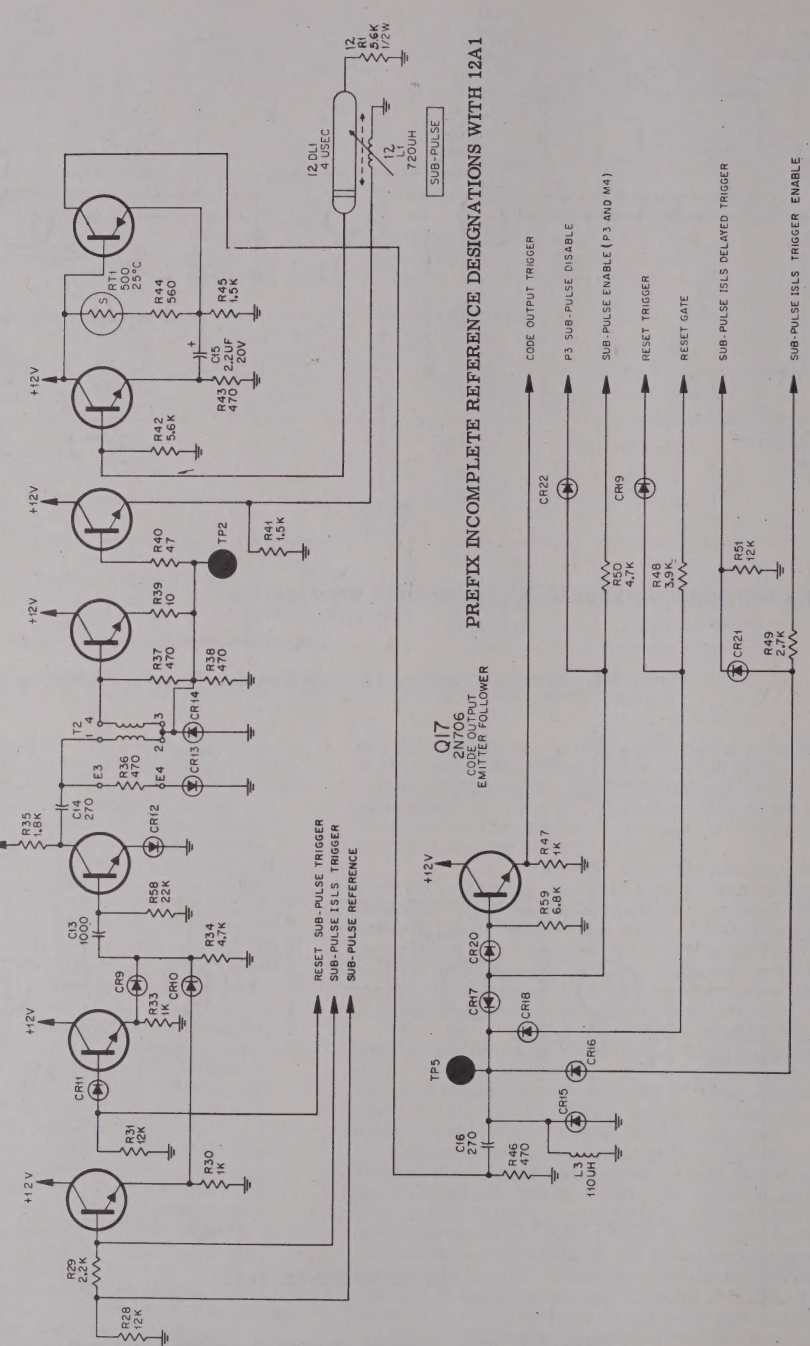


Figure 4-7. Substitute Pulse Circuits, Simplified Schematic Diagram

be switched to one of three different output channels for use as a code pulse substitute trigger, as an ISLS pulse substitute trigger, or as a reset pulse substitute trigger. When the sub pulse enable (P3 and M4) voltage is applied to the anodes of 12A1CR17 and 12A1CR20, the code trigger is allowed to pass to code output emitter follower 12A1Q17 and then out of the circuit. When a positive ISLS sub pulse trigger enable voltage is applied to the anodes of 12A1CR16 and 12A1CR21, the ISLS delayed sub pulse trigger is allowed to go out of the circuit. When a positive reset gate pulse (enable voltage) is applied to the anodes of 12A1CR18 and 12A1CR19, the reset tag delayed sub pulse trigger is allowed to pass on out of the circuit.

Also contained in the 12A1 assembly is the modulation emitter follower stage 12A1Q18 (figure 4-8). External modulating signals fed in are coupled through capacitor 12A1C17 to the base of modulation emitter follower 12A1Q18. The output of 12A1Q18 is coupled through diodes 12A1CR23 and 12A1CR24 to the contacts of Function Selector 12S4C.

The 12A1 assembly also includes a signal mixer stage (output emitter follower 12A1Q19) for combining the code, ISLS, SIF, and reset pulses into a composite pulse signal for test purposes (figure 4-9). When Function Selector 12S4 is in the TEST position, the composite pulse signal is made available at CODER OUT connector 12J5 through VIDEO LEVEL control 12R11.

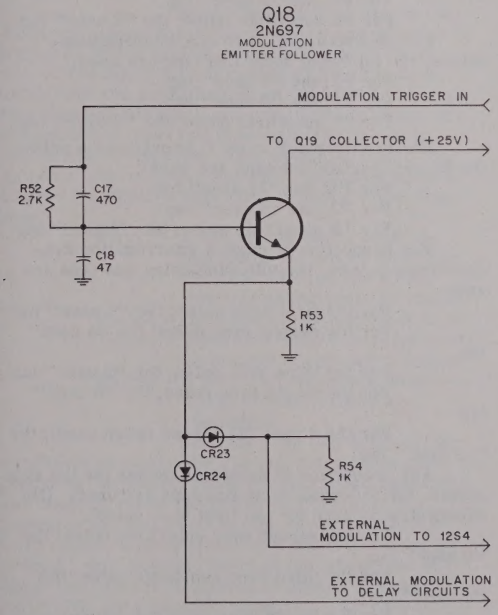
NOTE

The term "video" as used herein applies to either the pulse signals used for modulating the rf oscillator or those intended for viewing on the display.

2. DELAY LINE ASSEMBLY

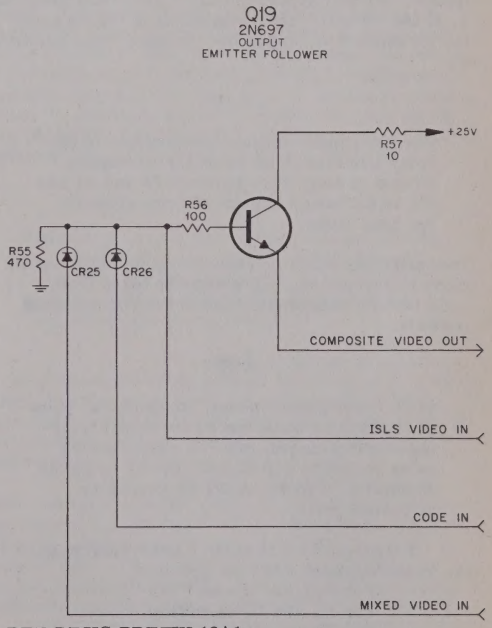
12A2. - The lumped-constant, terminated delay line 12A2DL1 is the basic element used in the formation of the interrogation pulse pattern. By passing a pulse down the delay line, it is possible to pick off a voltage pulse caused by the input pulse at any of the tap points along the line, each pulse picked off being successively delayed a slightly greater length of time. Two or more of these output pulses may be combined on a common output line to form a desired pulse pattern. The pulses having various time delays formed along Delay Line 12A2DL1 (figure 4-10) are put into use as required by means of the switching action of diode Matrix Assembly 12A3 in conjunction with the proper enabling voltages from the selector switches. The proper timing pulses from the clock circuits are also required.

Delay Line 12A2DL1 is driven by the positive output pulses from binary trigger input emitter follower 12A1Q4 in Clock and Line Drive Assembly 12A1. The pulses appearing at the "0" usec reference tap is used as the P3 pulse in all standard modes. Thus P3 will always remain



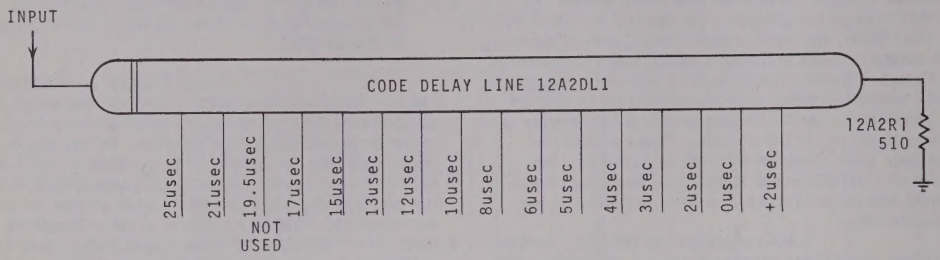
REF DESIG PREFIX 12A1

Figure 4-8. Modulation Emitter Follower, Simplified Schematic Diagram



REF DESIG PREFIX 12A1

Figure 4-9. Output Emitter Follower, Simplified Schematic Diagram



NOTE: Times assigned to taps refer to spacing with respect to the "0 usec" reference and not to actual delays.

Figure 4-10. Code Delay Line 12A2DL1, Simplified Schematic Diagram

constant, while P1 will vary in delay for different modes. P1 will appear at the "3 usec" tap for mode 1, at the "5 usec" tap for mode 2, at the "8 usec" tap for mode 3/A, and at the "21 usec" tap for mode C.

NOTE

The assignment of time designations to the delay line taps is based on the increasing amount of separation between P3 and P1 and not on the actual amount of delay given to the input pulse.

The substitute pulse reference trigger for standard mode interrogations will always be taken from a point two microseconds ahead of the normal pulse position.

NOTE

In all the standard modes, an ISLS (P2) pulse is obtained by using the P1 pulse and delaying it two microseconds. A substitute P2 pulse is obtained in these cases by using the undelayed P1 pulse as the P2 substitute reference pulse.

For production of mode 1 interrogation pulses, the following delay line taps are used.

For P1; the "3 usec" tap
For P3; the "0 usec" tap
For P3 substitute pulse; the "2 usec" tap (this pulse is later given an additional delay).

For production of mode 2 interrogation pulses, the following delay line taps are used:

For P1; the "5 usec" tap
For P3; the "0 usec" tap
For P3 substitute pulse; the "2 usec" tap

For production of mode 3/A interrogation pulses, the following delay line taps are used:

For P1; the "8 usec" tap
For P3; the "0 usec" tap
For P3 substitute pulse; the "2 usec" tap

For production of mode C interrogation pulses, the following delay line taps are used:

For P1; the "21 usec" tap
For P3; the "0 usec" tap
For P3 substitute pulse; the "2 usec" tap

For production of mode 4 interrogation synchronizing pulses, the following delay line taps are used:

For the first sync pulse; the "6 usec" tap
For the second sync pulse' the "4 usec" tap
For the third sync pulse; the "2 usec" tap
For the fourth sync pulse; the "0 usec" tap
For the 8 usec ISLS pulse (when used); the "+2 usec" tap

For production of substitute pulses for the sync pulses, the following delay line taps are used. (No substitution is used for the first sync pulse).

For the second sync substitute pulse; the "6 usec" tap
For the third sync substitute pulse; the "4 usec" tap
For the fourth sync substitute pulse; the "2 usec" tap
For the 8 usec ISLS substitute pulse; the "0 usec" tap

For production of reset tag pulses, the following delay line taps are used:

For reset tag pulse number one; the "25 usec" and "17 usec" taps.

For reset tag pulse number two; the "15 usec" and "13 usec" taps.

For reset tag pulse number three; the "10 usec" and "6 usec" taps.

It will be noted that the use of these delay line taps results in a spacing of two microseconds between pulses R1 and R2, and a spacing of three microseconds between R2 and R3.

For the production of substitute pulses for the reset tag pulses, a set of taps, each of which is two microseconds earlier, is used. No substitution is provided for reset pulse number one.

For reset tag substitute number two; the "17 usec" and "15 usec" taps.

For reset tag substitute number three; the "12 usec" and "8 usec" taps.

3. MATRIX ASSEMBLY 12A3.- The Matrix Assembly consists of an array of switching networks used for selecting the desired trigger pulses from those developed by Delay Line Assembly 12A2. For each switching network, several coincident conditions must be met before a pulse is allowed to pass. A pulse must be present at the line from the delay line tap of interest, a positive enabling voltage must be available to the switching diodes, a positive timing pulse from the clock circuits must be present, and the disabling diode must not be grounded.

All of the matrix switching circuits are basically similar and their operation is explained by the typical example shown in figure 4-11. The basic circuit consists of a gate diode 12A3CR64 and a coupling diode 12A3CR65. A positive enabling voltage is applied (through 12R25) to the anodes of these two diodes to turn the basic switch "on". However, this switching circuit requires a total of four coincident conditions in order to pass (in effect) a delay line pulse on to the output line:

First – a +12 volt potential must be applied to the anodes of diodes of 12A3CR64 and 12A3CR65 (through gating resistor 12R25).
Second – the disabling ground must be off;
Third – a positive delay line pulse must be present at the switch input;
Fourth – a positive clock pulse must be applied to the cathode of 12A3AR66.

When the first two of these four conditions are met, the +12 volt potential enables the circuit by forward-biasing the gate diode 12A3CR64 and coupling diode 12A3CR65, and no disabling ground is present to nullify the effect. When the third condition is met; that is a delay line pulse is present, still no pulse reaches the output line because the current is shorted to ground through 12A3CR66 and 12A1R27. However, when a clock pulse arrives at the same time, diode 12A3CR66 will be in a conductive state, and the clock pulse will back-bias it, causing a voltage rise at the junction of 12A3CR66 and 12A3CR65 which appears as a pulse on the output (P3) line. This pulse will have a width

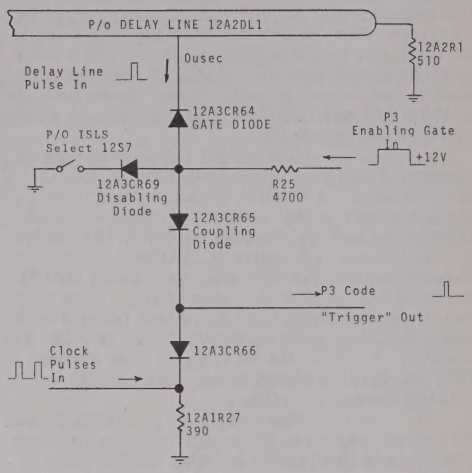


Figure 4-11. Typical Switching Section of Diode Matrix Assembly 12A3, Simplified Schematic Diagram

determined by that of the relatively narrow clock pulse. The pulse height will be determined by the lower of the potentials applied. When no delay line pulse is present, but +12 volts is present, current will flow through 12A3CR64, through the delay line, and back to ground through the terminating resistor. When the disabling switch is closed, the junction of the 12A3CR64 and 12A3CR65 diodes is held at ground potential and no pulse will reach the output line.

NOTE

Although it is seen that a delay line pulse does not actually pass through the switch circuit to the output, the expression "pass through" will be used for convenience throughout the rest of the circuit discussion.

To produce a pattern simulating a set of three reset tag pulses, three pairs of delay line taps are used. Each of the pulses from these taps represents the leading or trailing edge of one of the reset tag pulses. (These pairs of pulses are later processed to form individual pulses.)

For producing substitute (movable) pulses, an output from a tap (a pair of taps in the case of a reset tag pulse) is utilized which produces a pulse two microseconds earlier than the normal time. The resulting pulse may then be varied in position approximately 2 microseconds on both sides of the normal position.

When mode 1 operation is selected (for example) by means of Mode Selector 12S5, a positive enabling voltage is applied to the junction of diodes 12A3CR50 and 12A3CR51 (see overall Interrogation Coder Schematic Diagram, figure 5-65)

which biases them (and also 12A3CR8) into conduction permitting a "3 usec" pulse to pass out on the P1 trigger output line (if all other conditions are correct). At the same time, a positive clock pulse is applied to the cathode of 12A3CR8, causing it to conduct and causing a rise in voltage at the junction of 12A3CR50 and 12A3CR51 which appears as a pulse on P1 trigger output line.

The mode 1 interrogation signal consists of a pair of pulses spaced three microseconds apart. A positive trigger input at TRIG connector 12J1 is fed to external trigger amplifier 12A1Q1 in Clock and Recycle Assembly 12A1 where it is amplified. The output of 12A1Q1 is coupled in through capacitor 12A1C3 and transformer 12A1T1 to line drive blocking oscillator 12A1Q3. The shaped output pulses from 12A1Q3 are direct-coupled to the base of binary trigger emitter follower 12A1Q4. The output of 12A1Q4 is fed out to Delay Line Assembly 12A2 and is also coupled to the clock circuits (12A1Q5 through 12A1Q9).

Mode 1 trigger pulses for P1 and P3 respectively enter P1 trigger buffer 12A6Q2 and P3 trigger buffer 12A6Q1 in Delay and Tag Generator Assembly 12A6. The outputs from these buffers are combined on a common line to form the mode 1 code output triggers. They are fed to internal blocking oscillator amplifier 12A4Q1 in Blocking Oscillator Assembly 12A4 for use in the modulating circuits.

The method of generating mode 2, 3/A, and C interrogation pulses is the same as for mode 1 except that the P1 trigger pulse precedes the P3 trigger pulse by the amounts stated previously, that the enabling voltages are applied to different lines by the contacts of Mode Selector 12S5, and that the pulses pass through different switching diodes in Matrix Assembly 12A3.

When operating in mode 4, Mode Selector 12S5 is in the M4 SYNC position, so the Interrogation Coder is set up for simulating interrogations in the mode 4 pattern. This means that the preliminary mode 4 synchronizing pulses (spaced two microseconds apart) are supplied by the Interrogation Coder and the remaining pulses (up to 33) are supplied from an external source through the MOD connector on the Interrogation Coder.

4. SUBSTITUTE PULSE CIRCUITS.- The Interrogation Coder has the capability of providing variable pulse spacing (pulse shift) in the pulse pattern for any mode of interrogation. This is accomplished by removing a normal pulse from the pulse train, replacing it with a substitute pulse, and using the SUB PULSE position control to vary its position in the train. (See figure 4-7.)

Pulse position variability is achieved by starting the substitute pulse two microseconds earlier than the normal pulse position, and applying it to a 4-microsecond variable delay line. By changing the drive coil position on the delay line, the amount of delay can be varied and the pulse position adjusted over approximately 1.5 microseconds on either side of the normal position.

A substitute pulse can replace either the last interrogation pulse (designated as P3) or the ISLS pulse (P2) in standard IFF interrogations. In mode 4 interrogations, a substitute pulse can replace the second, third, or fourth synchronizing pulse, as well as the ISLS (8 usec) pulse. A substitute pulse may also be used to replace the second or third reset tag pulse.

In all standard modes, replacement of the P2 (ISLS) pulse with a substitute pulse requires that a variable-position pulse be put into the space two microseconds after the P1 pulse. For production of an ISLS pulse, ISLS Selector 12S7 is set to the 2 usec position. This will cause a +12 volt ISLS enable potential to be applied to the anodes of switch diodes 12A6CR6 and 12A6CR5 in ISLS and Tag Generator Assembly 12A6, permitting the output of P1 trigger buffer 12A6Q2 to pass to the ISLS delay multivibrator 12A6Q3/Q4.

To maintain this relationship, with the P2 pulse two microseconds after the P1 pulse in all standard modes, the P2 pulse is produced by using the P1 pulse to trigger a multivibrator which generates a pulse delayed by two microseconds. When a substitute P2 pulse is desired, Substitute Pulse Selector 12S6 is set to the P2 position, and this normal P2 pulse will be replaced by a variable-position pulse. The normal P2 pulse is removed by switching the P1 trigger off the delay multivibrator. The substitute P2 pulse is then processed like the other code pulse substitutions.

As stated before, for P2 pulse substitution, ISLS Selector 12S7 will be in the 2 usec position, and Substitute Pulse Selector 12S6 will be the P2 position. Under these conditions, a positive sub pulse enable (ISLS) voltage will be applied to diodes 12A6CR4 and 12A6CR8, providing a path for the P1 trigger from P1 trigger buffer 12A6Q2 through 12A6CR4 and 12A6CR8 to sub pulse reference emitter follower 12A1Q10 in Clock and Recycle Assembly 12A1. Since the P1 pulse is two microseconds ahead of the P2 pulse, the P1 pulse is utilized as the "2 usec early" reference pulse for substitute pulse production.

The positive enabling voltage on 12A6CR4 also serves to disable diodes 12A6CR3 and 12A6CR5 so that the P1 trigger is prevented from reaching the ISLS delay multivibrator 12A6Q3/Q4 and the normal ISLS pulse is eliminated from the output.

When using external ISLS triggering, a substitute pulse trigger for the ISLS delay multivibrator is fed in through resistor 12A6R84 and conducting switch diode 12A6CR4. The rest of the operation is the same as for internally-triggered ISLS pulse substitution. The Substitute Pulse Selector is set to P2 so as to permit diode 12A6CR2 to apply the initial IFF output pulse (P1) from P1 trigger buffer 12A6Q2 to sub pulse reference emitter follower 12A1Q10. This output pulse is amplified by sub pulse trigger amplifier 12A1Q12. The output of 12A1Q12 triggers sub pulse blocking oscillator 12A1Q13 which drives an adjustable delay line (12DL1). An output pulse of variable delay is available at sub pulse emitter follower 12A1Q15. This externally triggered delayed output pulse is sent to ISLS trigger emitter follower 12A4Q5 from where it follows the path described for internally-triggered ISLS pulses.

When Substitute Pulse Selector 12S6 is set to the P3 position, a +12 volt sub pulse reference enable potential is applied to the anodes of

switching diodes 12A3CR55 and 12A3CR56 in Matrix Assembly 12A3. This permits the passage of a "reference" pulse (which precedes the P3 pulse by two microseconds) to sub pulse reference emitter follower 12A1Q10 in Clock and Line Drive Assembly 12A1. The output of 12A1Q10 is coupled through 12A1CR10 and capacitor 12A1C13 to sub pulse trigger amplifier 12A1Q12 which feeds it through 12A1C14 and 12A1T2 to sub pulse blocking oscillator 12A1Q13. The output of blocking oscillator 12A1Q13 is fed to sub pulse line drive emitter follower 12A1Q14, the output of which is applied to the variable drive coil 12L1 of sub pulse delay line 12DL1. The desired delay is set by means of 12DL1 and the delay line output is coupled to sub pulse emitter follower 12A1Q15. The output of 12A1Q15 drives sub pulse shaper 12A1Q16, the output of which is gated on by the positive voltage applied to switch diodes 12A1CR17 and 12A1CR20, passing the signal to code output emitter follower 12A1Q17 which feeds it out to internal blocking oscillator amplifier 12A4Q1 in Blocking Oscillator Assembly 12A4. It is then processed like a normal modulating signal.

5. 40-MICROSECOND DELAY TRIGGER CIRCUITS. - A pulse delayed 40 microseconds from the input is available at OUT receptacle 12J4 during the simulation of interrogations in most modes. As shown in figure 4-12, the delay trigger signal from VIDEO selector switch 12S8 is fed to 40-microsecond delay trigger amplifier 12A6Q6 in Delay and Tag Generator Assembly 12A6. The output of 12A6Q6 is coupled to 40 usec delay multivibrator 12A6Q7/Q8. The output from 12A6Q8 is gated on and off by the code gate applied to the anode of 12A6CR13.

Multivibrator output pulses are applied to 40-microsecond delay blocking oscillators 12A6Q9 and 12A6Q10 for pulse shaping. A 40-microsecond delayed output trigger from 12A6Q10 is made available at OUT receptacle 12J4 for application to the SIF Coder. This permits the simulation of the composite video from a reply signal consisting of the following:

First – a set of the original interrogation pulses serving as mode identification tags;

Second – a set of SIF code reply pulses (delayed 40 microseconds for proper spacing) containing bracket and information pulses, and

Third – a set of three special reset pulses which serve to indicate the end of the receiver "on" time for each prf period.

(b) MODULATING SECTION. - There are two possible sources of pulses for the input of the modulating circuits. One source is the coder section of the Interrogation Coder and the other is an external source connected to MOD connector 12J3. Function Selector 12S4 determines which of the two sources is used.

In addition to the pulse input, the modulating circuits require a dc voltage input to

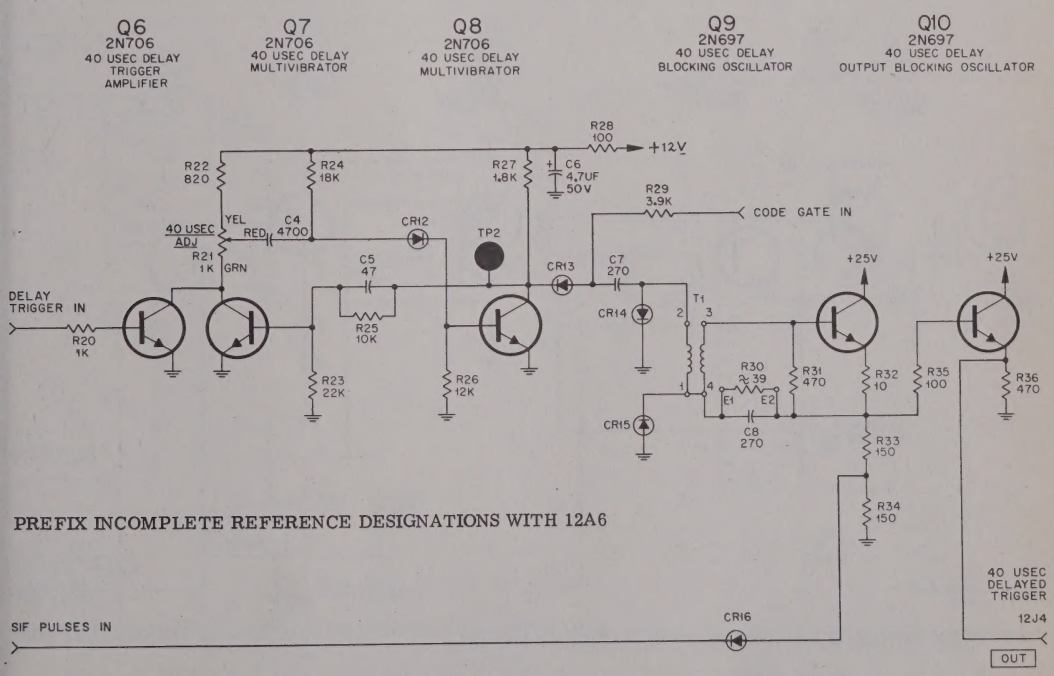


Figure 4-12. 40-μsec Delay Trigger Generating Circuits, Simplified Schematic Diagram

accomplish the automatic level control function. This dc voltage is provided by the ALC amplifier in the Calibration-Control unit.

The output of the modulating section can go to either of two possible places, depending upon the setting of Function Selector 12S4. One destination is the main rf oscillator, located on the SM-197A chassis. The other is CODER OUT connector 12J5, where the input signal level can be adjusted by means of the VIDEO LEVEL control.

Modulating signals are processed by two separate sections of circuitry in the Interrogation Coder: the Blocking Oscillator Assembly 12A4 and the electron tube modulating circuits.

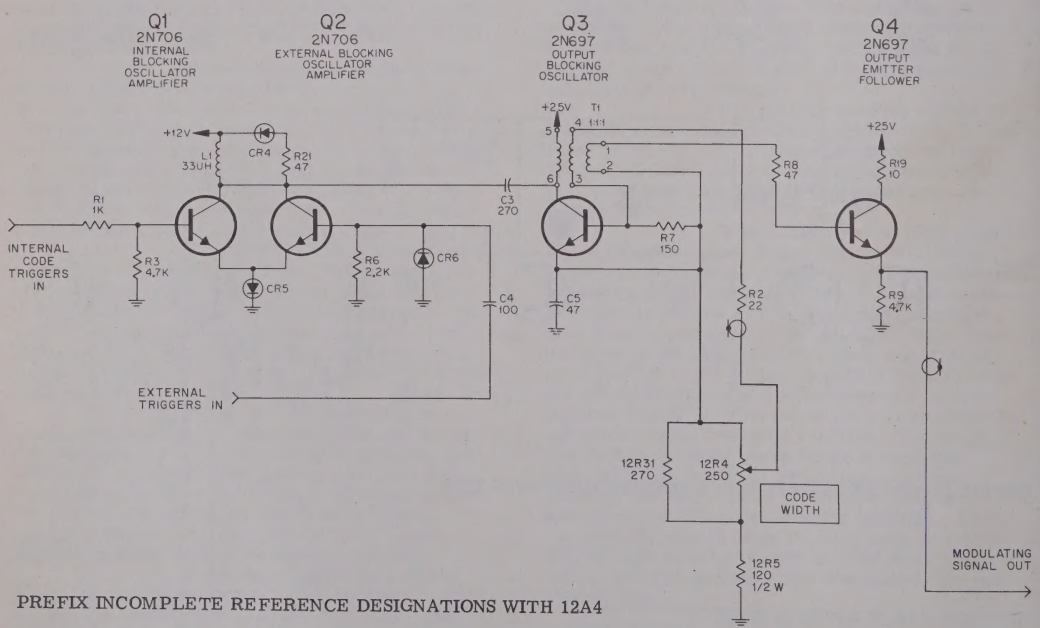
1. BLOCKING OSCILLATOR ASSEMBLY 12A4.- This assembly contains transistor blocking oscillator circuits for producing pulses to be used in modulating both the main rf oscillator and the ISLS rf oscillator. Both blocking oscillators may be triggered by either internally-produced or externally-produced pulse signals.

When Function Selector 12S4 is in the MOD-INT position, the internal modulating code output signal from Delay and Reset Pulse Generator Assembly 12A6 is applied to the input of internal blocking oscillator amplifier 12A4Q1. (This signal consists of the basic interrogation pulses P1 and P3 for standard modes, and consists of four synchronizing pulses for mode 4 interrogations.)

Internal blocking oscillator amplifier 12A4Q1 and external modulation blocking oscillator amplifier 12A4Q2 share a common collector load (figure 4-13). The collector output of 12A4Q1 is coupled through capacitor 12A4C3 to output blocking oscillator 12A4Q3. The width of the pulse produced by this blocking oscillator is controlled by means of CODE WIDTH control 12R4. The output of the blocking oscillator is fed to output emitter follower 12A4Q4. The output of 12A4Q4 is passed through the contacts of Function Selector 12S4, and through coupling capacitor 12C1 to the input of pulse amplifier 12V1. The output of the pulse amplifier is clamped by output clamper 12V2A to the positive level determined by the ALC circuit, and again by output clamper 12V2B, and then coupled to the grid of modulator cathode follower 12V3.

The output of 12V3 is passed through the contacts of Function Selector 12S4, and through connector 12J6 to the rf oscillator circuits on the SM-197A chassis. When Function Selector 12S4 is in the MOD-LOW position, the positive pulses from connector 12J3 which are coupled to modulation emitter follower 12A1Q18 (in Clock and Line Drive Assembly 12A1) are then fed through the contacts of switch section 12S4C, front, to the input of external blocking oscillator amplifier 12A4Q2 in Blocking Oscillator Assembly 12A4. The output of 12A4Q2 is coupled through capacitor 12A4C3 to output blocking oscillator 12A4Q3.

From this point on the circuits are the same as for internal modulation. When internal modulating signals are used, the code output trigger signal from ISLS and Tag Generator Assembly 12A6 is applied to internal blocking oscillator



PREFIX INCOMPLETE REFERENCE DESIGNATIONS WITH 12A4

Figure 4-13. Code Modulation Blocking Oscillator Circuit, Simplified Schematic Diagram

amplifier 12A4Q1 in Blocking Oscillator Assembly 12A4. The output of 12A4Q1 is coupled through capacitor 12A4C3 to output blocking oscillator 12A4Q3. The output of 12A4Q3 is fed to output emitter follower 12A4Q4. The output of 12A4Q4 is passed through the contacts of Function Selector 12S4 (when in the MOD-INT position) to the input of the electron-tube modulating circuits (12V1, 12V2, and 12V3).

For external modulation, the modulating signal source is connected to MOD connector 12J3. Function Selector 12S4 is set to either MOD-HIGH or MOD-LOW position, depending upon whether the signal amplitude is over or under 20 volts.

The MOD-LOW position of Function Selector 12S4C routes external input signals from MOD connector 12J3 through modulation emitter follower 12A1Q18 in Clock and Line Drive Assembly 12A1, back through the contacts of Function Selector 12S4C to external blocking oscillator amplifier 12A4Q2, output blocking oscillator 12A4Q3, output emitter follower 12A4Q4 again through Function Selector 12S4C, and into pulse amplifier 12V1 in the electron tube modulator circuits.

For external modulating pulses of over 20 volts amplitude, Function Selector 12S4 is set to MOD-HIGH position. In this position the input signal is routed through modulation emitter follower 12A1Q18 in Clock and Line Drive Assembly 12A1, back through the contacts of Function Selector 12S4C, and directly into pulse amplifier 12V1 in the electron tube modulator section. When SIF Coder pulses are being used as external input pulses, the pulse width will be controlled by the SIF coder in the MOD-HIGH position and in the MOD-LOW position it will be controlled by the interrogation coder. It is recommended in the MOD-LOW position that a narrow pulse be fed in for better operation.

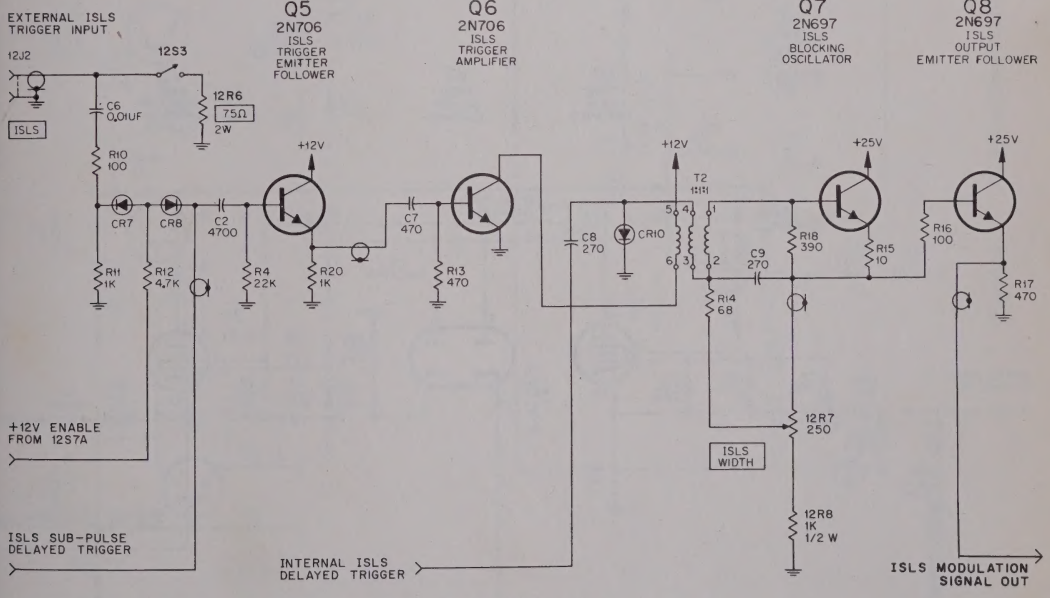
Setting Function Selector 12S4 to the MOD-INT position routes the code output trigger from P3 trigger buffer 12A6Q1 and P1 trigger buffer 12A6Q2 (in ISLS and Delay Pulse Generator Assembly 12A6) through internal blocking oscillator amplifier 12A4Q1, output blocking oscillator 12A4Q3, output emitter follower 12A4Q4, and through the contacts of 12S4C into pulse amplifier 12V1 in the electron tube modulator section.

When Function Selector 12S4 is set to the MOD-MIX position, an external trigger at MOD connector 12J3 follows a path identical to that taken in the MOD-HIGH position. The code output trigger is also fed into pulse amplifier 12V1 in the electron tube modulator section through the contacts of Function Selector 12S4C.

The TEST position of Function Selector 12S4 applies the external modulation input trigger from output emitter follower 12A4Q4 to CODER OUT connector 12J5.

When Function Selector 12S4 is set to (+) or (-), either positive or negative-going pulses are made available at CODER OUT connector 12J5.

When an ISLS pulse is to be produced, the ISLS blocking oscillator 12A4Q7 and associated circuits is used (figure 4-14). When an internally generated trigger is used, it is applied to



PREFIX INCOMPLETE REFERENCE DESIGNATIONS WITH 12A4

Figure 4-14. ISLS Modulation Blocking Oscillator Circuit, Simplified Schematic Diagram

blocking oscillator transformer 12A4T2, triggering the blocking oscillator. The width of the blocking oscillator pulse is adjusted by ISLS WIDTH control 12R7. The output of 12A4Q7 is direct-coupled to ISLS output emitter follower 12A4Q8.

When an external trigger source is used, it is connected to ISLS connector 12J2, and a +12 volt enabling potential is applied to switching diodes 12A4CR7 and 12A4CR8. The diodes conduct, permitting the pulse to pass through the ISLS trigger emitter follower 12A4Q5. The output of 12A4Q5 is amplified by ISLS trigger amplifier 12A4Q6 before being applied to the blocking oscillator. From here on, the pulse is processed as for internal triggering, and is passed out of the assembly to Rf (ISLS) Subassembly 12A5.

2. ELECTRON TUBE MODULATING CIRCUITS.- The electron tube modulating circuits consist of three stages, pulse amplifier 12V1, output clamper 12V2, and modulator cathode follower 12V3 (figure 4-15). The input to the first stage, 12V1, is determined by the setting of Function Selector 12S4C. The input signal is fed through coupling capacitor 12C1. Pulse amplifier 12V1 is a cathode-driven pentode.

The positive peaks of the output from the plate of 12V1 are clamped at the dc level set by the first diode section (A) of output clamper 12V2 which is biased by the ALC circuit in the Calibration-Control unit. This type of modulator control maintains a constant-level signal generator pulse output. The output from 12V1 is coupled through capacitor 12C5 and parasitic suppressor 12R19 to the grid of modulator cathode follower 12V3. At the same time it is coupled to output clamper 12V2B which is connected across the 12V3 grid-return resistor 12R18. The plate load resistor 12R15 of 12V1 is tapped to provide a screen voltage for 12V3 which tends to rise with an increase in duty cycle. This effect compensates for the normal tendency for the screen voltage to drop. Resistor 12R20 and inductor 12L3 function as a compensated load for the cathode of 12V3. Positive output pulses from 12V3 are applied to the rf oscillator in the SM-197A chassis through the contacts of Function Selector 12S4B, front, and connector 12J6.

When Function Selector 12S4 is set to the MOD-HIGH, MOD-LOW, MOD-INT, or MOD-MIX position, the input to 12V1 is as described previously. However, when the selector is in the TEST position, no signal is applied to 12V1, but the signal is routed directly to CODER OUT connector 12J5 instead of to the modulator circuits.

(c) RF (ISLS) SUBASSEMBLY 12A5.- This assembly contains the circuits for generating an independent rf signal to be used in simulating an ISLS reference signal, and also the circuits for pulse modulating the rf signal using either an internally or externally generated modulating signal.

1. OSCILLATOR CIRCUIT.- The initial source for the ISLS signal is Crystal-Controlled Oscillator 12A5Q1 (figure 4-16). The basic oscillator frequency of 85.833 mHz is set by frequency-control crystal 12A5Y1. Oscillator

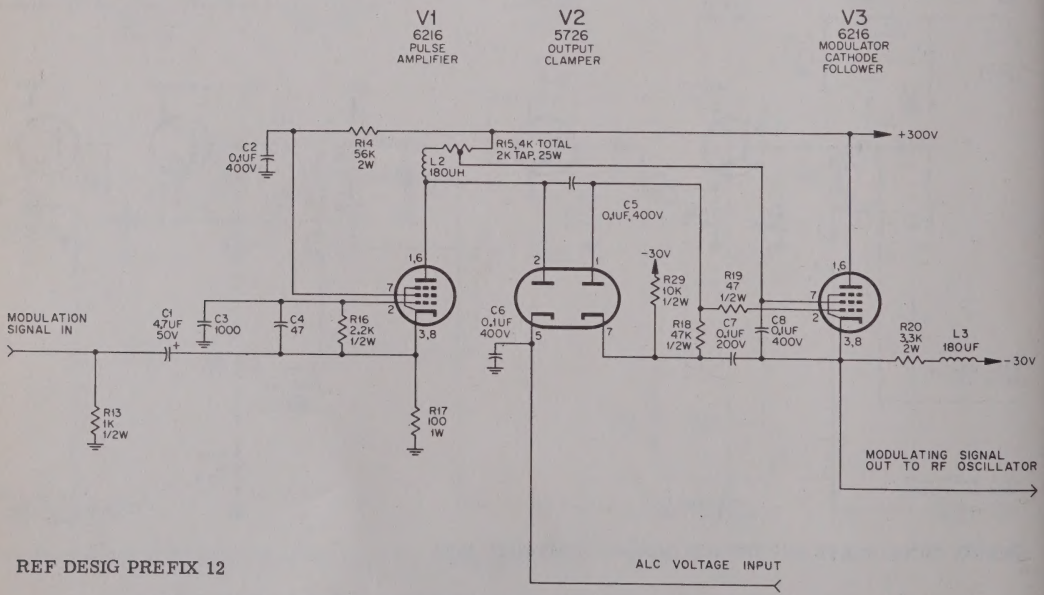
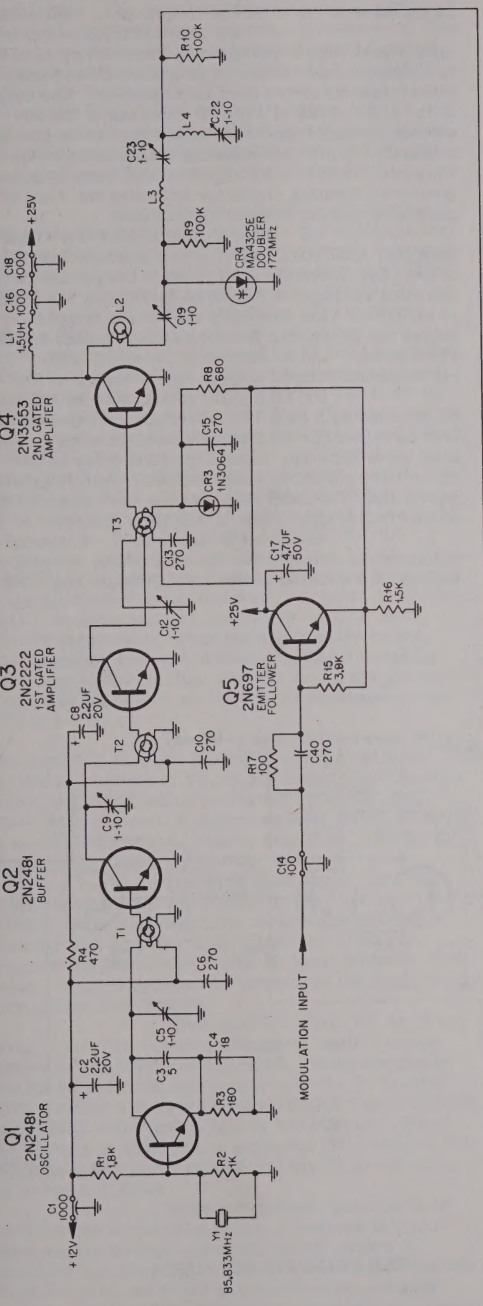


Figure 4-15. Electron Tube Modulating Circuits, Simplified Schematic Diagram



REF DESIG PREFIX 12A5

Figure 4-16. ISLS Oscillator Circuits, Simplified Schematic Diagram

12A5Q1 operates continuously when input power is applied. The output at the collector of 12A5Q1 is transformer-coupled to buffer 12A5Q2. Transformer 12A5T1 is tuned to 85.833 mHz by means of variable capacitor 12A5C5. The output of buffer 12A5Q2 is applied to the base of gated amplifier 12A5Q3 through transformer 12A5T2.

2. PULSE MODULATION CIRCUITS.- Gated amplifier 12A5Q3 is normally disabled by the grounding of the collector through the primary of transformer 12A5T3 and the emitter resistor 12A5R16 of the "normally off" emitter follower 12A5Q5. When a positive modulation pulse from either an external source (through the ISLS pulse-processing circuits in blocking oscillator assembly 12A4) or an internal source (the normal modulating signal selected by section 12S4B, front of the Function Selector) is fed to the base of 12A5Q5, the transistor conducts, applying 25 volts to the collector of 12A5Q3 through the primary of 12A5T3. This causes 12A5Q3 to be enabled for the duration of the pulse.

3. FREQUENCY MULTIPLIERS. The 85.833 mHz signal at the output of 12A5Q4 is applied to varactor diode 12A5CR4, which acts as a harmonic generator and (in conjunction with the associated tuned circuits), doubles the frequency to 171.667 mHz. This frequency is then tripled by means of varactor diode 12A5CR5 to obtain a signal frequency of 515 mHz. The 515 mHz signal is coupled to the cathode of grounded-grid rf amplifier 12A5V1 which amplifies the signal and applies it through transformer 12A5T6 to varactor diode 12A5CR6 which doubles the frequency to 1030 mHz.

4. RF AMPLIFIERS.- The 1030 mHz signal (which was already amplified by 12A5V1) is coupled to the cathode of grounded-grid rf amplifier 12A5V2 for further amplification. The output of the plate cavity of 12A5V2 is fed out of the assembly through connector 12A5J2 for use as a pulse-modulated rf signal simulating ISLS transmission. This precise 1030 mHz signal is also used as a frequency-calibrating signal for adjusting the main rf oscillator and for similar applications.

(d) DELAY AND RESET TAG GENERATOR ASSEMBLY 12A6.- The primary function of the 12A6 assembly is to produce the pulses which are used as triggers for pulse-modulating the ISLS rf circuits. This assembly also mixes trigger pulses for generating the normal code trains and the reset pulses, and in addition it produces a 40-microsecond delayed trigger signal (figure 4-12).

An ISLS pulse (designated as P2) can be supplied with each IFF interrogation pulse train (see table 3-2 for ISLS pulse characteristics). The ISLS pulse normally follows the first pulse in the train (P1) by 2 ±0.05 microseconds, when triggered internally. The ISLS pulse can also be triggered by an external trigger pulse at any time desired.

As shown in figure 4-17, if internal triggering is selected for the ISLS pulse, proper biasing on switching diodes 12A6CR5 and 12A6CR6

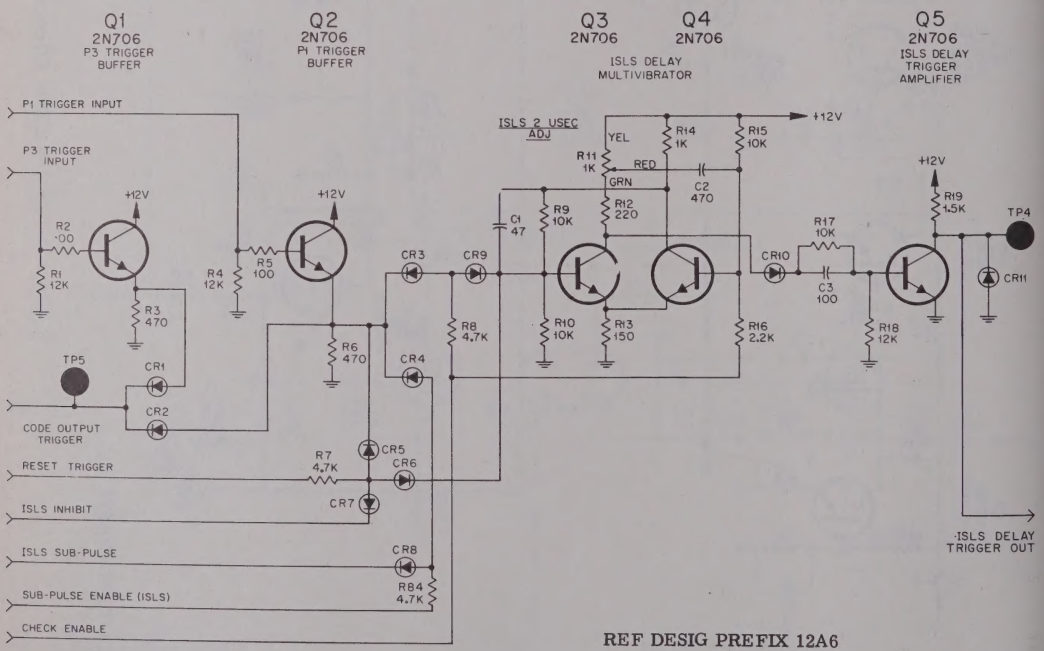


Figure 4-17. ISLS and Code Trigger Generating Circuits, Simplified Schematic Diagram

allows the first IFF interrogation pulse from P1 trigger buffer 12A6Q2 to trigger ISLS delay multivibrator 12A6Q3/Q4. The multivibrator output is a pulse which follows the P1 input by two microseconds. The output pulse is amplified and shaped by ISLS delay trigger amplifier 12A6Q5, ISLS blocking oscillator 12A4Q7 (in Blocking Oscillator Assembly 12A4), buffered by ISLS output emitter follower 12A4Q8, and sent simultaneously to RF Subassembly 12A5 as a modulation input to emitter follower 12A5Q5, and to connector 12J6 for modulating the main rf oscillator.

If an external signal is selected for triggering the ISLS pulse, the circuit function is the same as that for internal triggering except that an external trigger from the ISLS connector is used to trigger the ISLS delay multivibrator 12A6Q3/Q4 (figure 4-17). The ISLS connector 12J2 presents either a high impedance or a low impedance (75 ohms), depending upon the position of the associated terminating switch 12S3. The input trigger passes through switching diodes 12A4CR7 and 12A4CR8 (in Blocking Oscillator Assembly 12A4) which are turned on by the +12 volt bias from ISLS Selector 12S7A in the EXT position. The trigger pulse is then shaped by ISLS trigger emitter follower 12A4Q5, and amplified by ISLS trigger amplifier 12A4Q6 before being used to trigger ISLS blocking oscillator 12A4Q7.

1. CODE PULSE CIRCUITS.- To produce a set of code trigger pulses, (including the ISLS pulse when used) the triggers are combined in the circuits of Delay and Tag Generator Assembly 12A6. Included in the assembly is an ISLS delay multivibrator which produces a gate pulse two microseconds long which fires the ISLS blocking oscillator on the trailing edge (in any of the standard modes) which serves as the P2 (ISLS) trigger pulse (figure 4-17).

The P3 trigger input (from delay line 12A2DL1 through Matrix Assembly 12A3) is applied to the base of P3 trigger buffer 12A6Q1. The output of 12A6Q1 will pass through coupling diode 12A6CR1 to the code triggers outline, which feeds it to internal blocking oscillator amplifier 12A4Q1 in Blocking Oscillator Assembly 12A4.

The P1 trigger input (from Matrix Assembly 12A3) is applied to the base of P1 trigger buffer 12A6Q2. The output of 12A6Q2 will pass through coupling diode 12A6CR2 to the code triggers out line where it will go along with the P3 pulse. This pair of pulses comprises the basic interrogation code pattern.

When an ISLS pulse (P2) is to be used, a positive enabling voltage is applied to the anodes of 12A6CR5 and 12A6CR6. When the diodes are forward-biased and conducting, the P1 trigger from 12A6Q2 will pass through 12A6CR5 and 12A6CR6 to the ISLS delay multivibrator 12A6Q3/Q4. When the cathode of 12A6CR7 is grounded (ISLS inhibit) the diode acts as a short circuit and the P1 is not allowed to reach 12A6Q3.

When a substitute pulse is to be used instead of the ISLS pulse, a positive ISLS sub pulse enable voltage is applied to the anodes of 12A6CR4 and 12A6CR8. This provides a path for the P1 pulse to go out to the substitute pulse circuits instead of to the ISLS delay multivibrator.

The ISLS Trigger pulse from the multivibrator (delayed 2 microseconds) is amplified by ISLS delay trigger amplifier 12A6Q5. The output of 12A6Q5 is fed out of the assembly to ISLS blocking oscillator 12A4Q7 (in Blocking Oscillator Assembly 12A4) for shaping.

2. RESET TAG GENERATING CIRCUITS.- When reset "tag" pulses are selected, pairs of reset triggers from Matrix Assembly 12A3 are fed into reset trigger emitter follower 12A6Q16 (figure 4-18). The output of 12A6Q16 is fed through capacitor 12A6C12 and diode 12A6CR18 to reset trigger amplifier 12A6Q17. The output of 12A6Q17 is fed through steering diodes 12A6CR19 and 12A6CR20 to both sides of reset tag binary generator 12A6Q18/Q19 which puts out a single pulse for each pair fed into it. When a substitute reset pulse is used, a trigger is fed directly into 12A6Q17. The output pulses from 12A6Q19 have a length equivalent to the spacings of the pulse pairs fed in. These pulses are applied to the base of tag buffer emitter follower 12A6Q20. The input to 12A6Q20 is gated on when the positive reset gate pulse is applied to the cathode of gating diode 12A6CR21. The output of 12A6Q20 is coupled through capacitor 12A6C17 to the emitter of tag amplifier 12A6Q21. The output of 12A6Q21 is coupled to tag output emitter follower 12A6Q22. The output from 12A6Q22 is adjusted by tag amplitude control 12A6R69 and fed out through coupling diode 12A6CR22.

3. CODE/RESET GATE GENERATING CIRCUITS.- When reset pulses are selected, both a reset gate pulse and a reset gate pulse trigger are also required. This reset gate is essentially a pulse having opposite polarity and occurring alternately in time with the code gate pulse. Both gate pulses are produced by the circuits in Delay and Tag Generator Assembly 12A6 (figure 4-19).

The reset gate trigger input is applied to code gate trigger amplifier 12A6Q12, which shares a common collector load with 12A6Q13 (one half of the code reset gate multivibrator 12A6Q13/Q14). The output from 12A6Q12 is coupled to code gate emitter follower output 12A6Q11 from where it is put out as a negative-going 12-volt code gate pulse.

The output from 12A6Q12 is also coupled to 12A6Q13 which is one half of code/reset gate multivibrator 12A6Q13/Q14. The output of 12A6Q14, a positive-going pulse starting where the code gate leaves off, is coupled to tag gate emitter follower output 12A6Q15, from where it is routed out of the assembly.

4. DELAYED RECYCLE TRIGGER CIRCUITS.- When a composite reply video signal containing mode identification tags, SIF code pulses, and reset pulses is to be simulated, the interrogation pulse pattern must be developed for mode identification, the SIF code pulses must be put into place, and then, after a proper delay, the reset pulses must be put into place. To accomplish this, the interrogation pulses are developed by delay line 12A2DL1 as usual, a 40-usec delay trigger is used to trigger the SIF Coder, and then, 21 microseconds after the last SIF pulse, a recycle action is started to allow the interrogation code delay line to produce

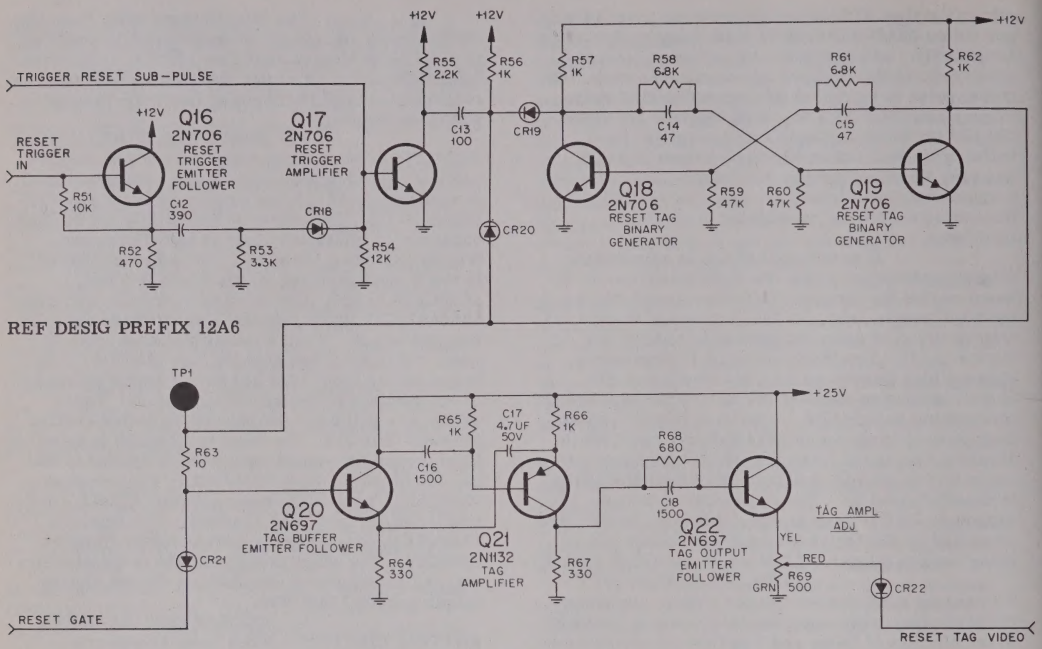


Figure 4-18. Reset Pulse Generating Circuits, Simplified Schematic Diagram

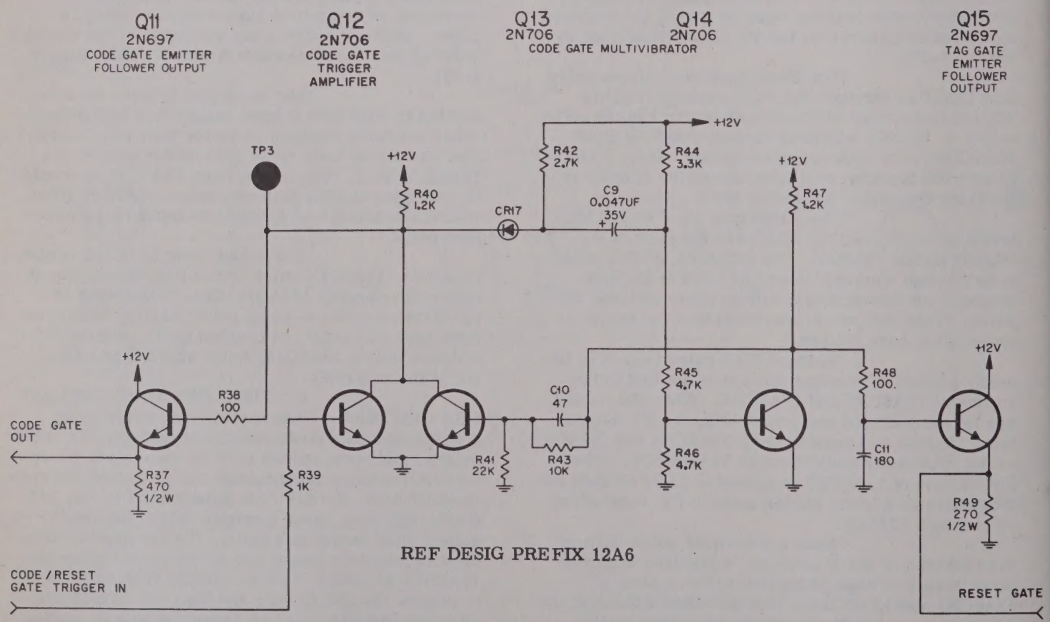


Figure 4-19. Reset Gate Generating Circuits, Simplified Schematic Diagram

a second set of pulses, this time consisting of pulse pairs used to make three reset tag pulses. Starting this recycling action at the proper time is done by integrating the SIF pulse train, so that the recycle multivibrator will be actuated by the voltage level appearing 21 microseconds after the last SIF pulse (figure 4-20).

The SIF reply video signal is fed into the integrating circuit made up of.12A6Q23, 12A6Q24, 12A6Q25, and 12A6Q26. The time constant of the 12A6Q23/Q24 collector circuit is adjusted by 21 usec DELAY ADJ 12A6R76 to set the spacing of the first reset pulse 21 microseconds from the last pulse in the SIF reply pulse train. The negative pulse appearing at the collectors of 12A6Q23/24 back-biases 12A6CR24 and causes 12A6Q25 to cut off, causing capacitor 12A6C20 to charge up. When the charge on 12A6C20 reaches a sufficiently high potential, 12A6Q25 is again allowed to conduct. The resulting pulse is passed through 12A6Q26 and on to the contacts of VIDEO selector switch 12S8 for distribution as a delayed recycle trigger pulse.

(e) CONTROL CIRCUITS.-

1. VIDEO SELECTOR 12S8.- This switch (figure 4-21) distributes +12 volt enabling potentials as described below:

"CODE" POSITION – Connects +12 volts to Mode Selector 12S5, permitting normal selection of coded interrogations. Applies disabling ground to delayed recycle trigger line and reset gate trigger line.

"RESET" POSITION – Removes disabling ground from reset gate trigger line and delayed recycle trigger line, permitting reset line drive pulse to reach switch diode pairs 12A3CR29 and 12A3CR30 ("6 usec"), 12A3CR25 and 12A3CR26 ("10 usec"), 12A3CR17 and 12A3CR18 ("15 usec"), 12A3CR9 and 12A3CR10 ("17 usec"), and 12A3CR3 and 12A3CR4 ("25 usec") to permit the generation of reset tag pulses. At the same time, the trigger line to the 40-usec delay trigger amplifier 12A6Q6 is broken to prevent production of the 40-usec trigger. Also applies disabling ground to Mode Selector 12S5 to prevent the generation of interrogation pulses. Connects reset gate trigger to recycle trigger amplifier 12A1Q2.

"BOTH" POSITION – Permits application of enabling reset gate pulse to same switch diodes as in RESET, permitting generation of reset pulses. Applies delayed

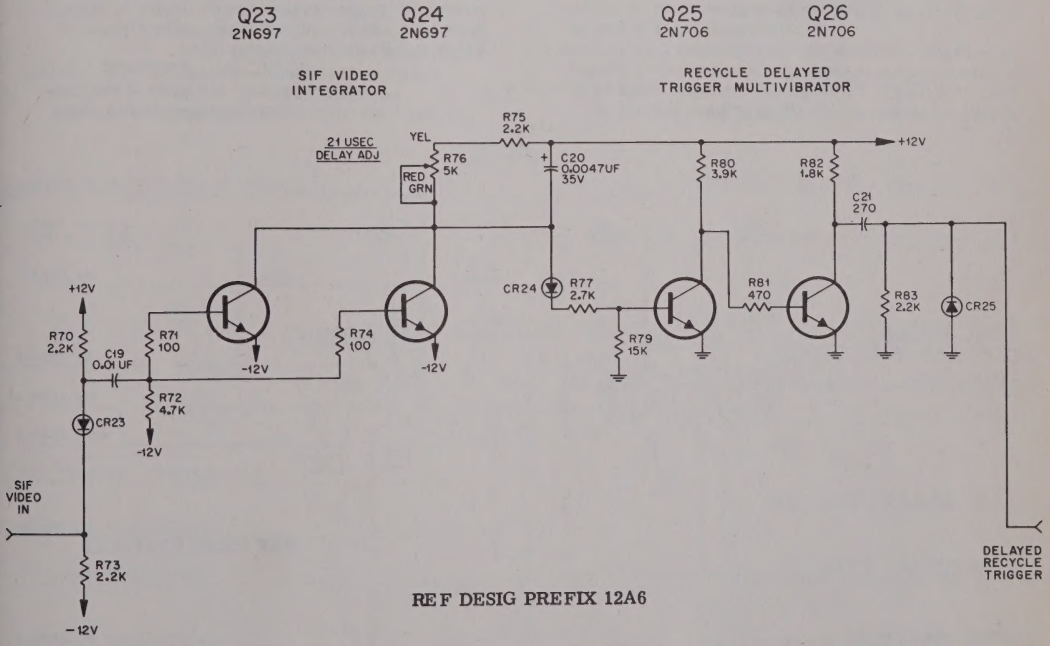


Figure 4-20. Delay Recycle Trigger Generator Circuits, Simplified Schematic Diagram

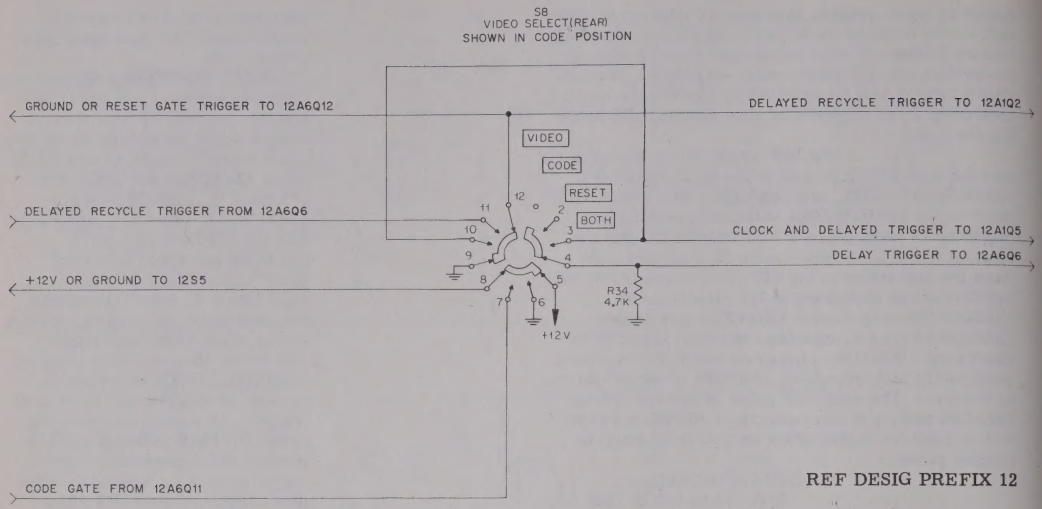


Figure 4-21. Video Selector, Simplified Schematic Diagram

recycle trigger to recycle trigger amplifier 12A1Q2 to initiate reset part of cycle. Also connects code gate line to Mode Selector 12S5, permitting generation of normal code interrogations (for use as mode identification tags). Connects clock and delayed trigger line to delay trigger input to 40-usec delay trigger circuit to develop a 40-usec delayed trigger for use by the SIF Coder.

2. MODE SELECTOR 12S5. - This switch (figure 4-22) distributes +12 volt enabling potentials to appropriate switch diodes in Matrix Assembly 12A3, and to the sub pulse circuits in Clock and Recycle Assembly 12A1.

"SYNC M4" POSITION – In this position, the mode 4 enabling voltage is connected to diode

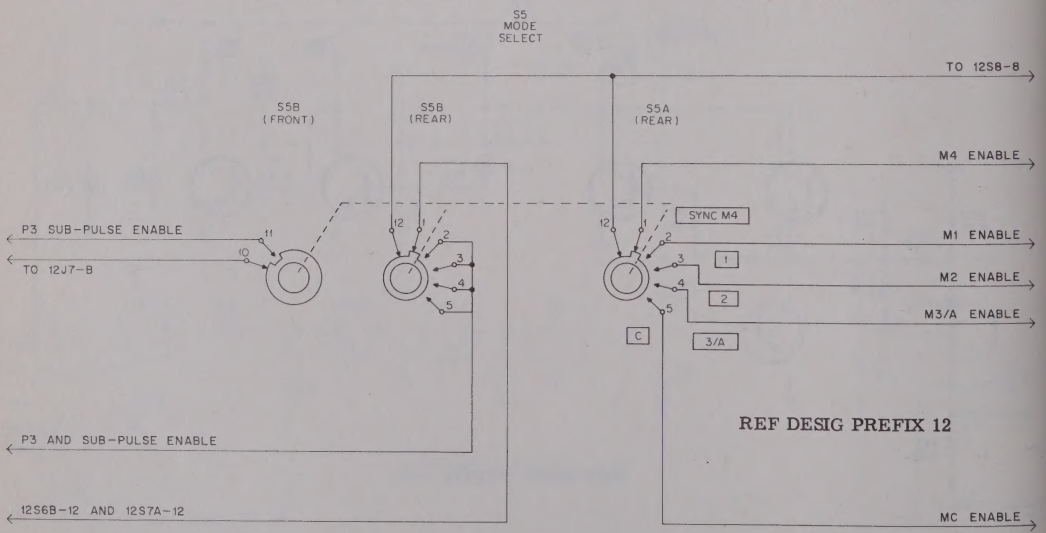


Figure 4-22. Mode Selector Control Circuits, Simplified Schematic Diagram

switch pairs 12A3CR53 and 12A3CR54, 12A3CR44 and 12A3CR45, and 12A3CR40 and 12A3CR41 in Matrix Assembly 12A3, permitting the passage of the 2 microsecond, 4 microsecond, and 6 microsecond mode 4 synchronizing pulses from the delay line. An enabling voltage is also connected to switch diodes 12A3CR70 and 12A3CR72 enabling the normal P3 pulse for use as the first mode 4 sync pulse. At the same time, an enabling voltage is applied to the sub pulse circuits in Clock and Line Drive Assembly 12A1.

"1" POSITION – Enabling voltages are connected to switch diode pair 12A3CR50 and 12A3CR51 to enable the mode 1 P1 Pulse, and to 12A3CR64 and 12A3CR65 to enable the P3 pulse.

"2" POSITION – Enabling voltages are connected to switch diode pair 12A3CR47 and 12A3CR43 to enable the mode 2 P1 pulse and to 12A3CR64 and 12A3CR65 to enable the P3 pulse.

"3/A" POSITION – Enabling voltages are connected to switch diode pairs 12A3CR31 and 12A3CR32 to enable the mode 3/A P1 pulse and to 12A3CR64 and 12A3CR65 to enable the P3 pulse.

"C" POSITION – Enabling voltages are connected to switch diode pair 12A3CR6 and 12A3CR7 to enable the mode C P1 pulse and to 12A3CR64 and 12A3CR65 to enable the P3 pulse.

3. ISLS SELECTOR 12S7 – This switch determines the selection of ISLS triggering sources by distributing enabling voltages and ground connections as described below: (figure 4-23)

"OUT" POSITION – No connections are made and no ISLS pulses are used, and the 300 volt source is removed from the ISLS tubes.

"EXT" POSITION – Applies enabling voltage to switch diode pair 12A4CR7 and 12A4CR8, permitting an external trigger signal from ISLS connector 12J2 to be placed on the base of ISLS trigger emitter follower 12A4Q5. The 300 volt source is connected to the ISLS tubes.

"CHECK" POSITION – Applies +12 volt check enable voltage to the anodes of diodes 12A6CR3 and 12A6CR9, permitting the passage of a P1 trigger pulse from P1 trigger buffer 12A6Q2 to ISLS delay multivibrator 12A6Q3/Q4. Also applies 12 volt check enable potential to 12A6Q4, causing it to conduct and produce a 0.3 to 0.6 microsecond delayed ISLS output trigger. This results in the ISLS pulse coinciding with the P1 pulse for the purpose of checking "zero beat" of the two rf signal generators.

"2 usec" POSITION – Applies an enabling voltage to the junction of diodes 12A6CR5, 12A6CR6, and 12A6CR7 through resistor 12A6R7,

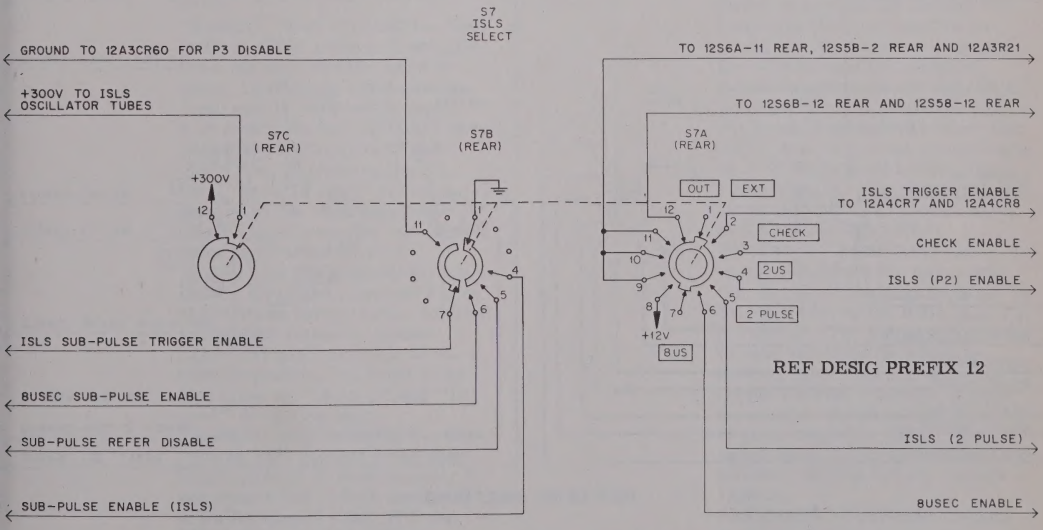


Figure 4-23. ISLS Control Circuits, Simplified Schematic Diagram

allowing P1 pulse from P1 trigger buffer 12A6Q2 to trigger the normal ISLS delay multivibrator operation. Connects Substitute Pulse Selector 12S6 for use if desired.

"2 PULSE" POSITION – Applies enabling voltage to switch diodes 12A3CR62 and 12A3CR63, allowing the 0 microsecond reference pulse to be used as the ISLS trigger. Also supplies a ground connection through 12A3CR69 to switch diodes 12A3CR64 and 12A3CR65 to prevent normal IFF P3 pulse generation and connects sub pulse enable line for use if desired.

"8 usec" POSITION – Applies enabling voltage to switch diodes 12A3CR74 and 12A3CR75, enabling the production of the mode 4 ISLS pulse from the "+2 usec" delay line tap. (A fifth pulse placed 2 usec after the fourth mode 4 sync pulse.) Connects sub pulse enable line for use if desired.

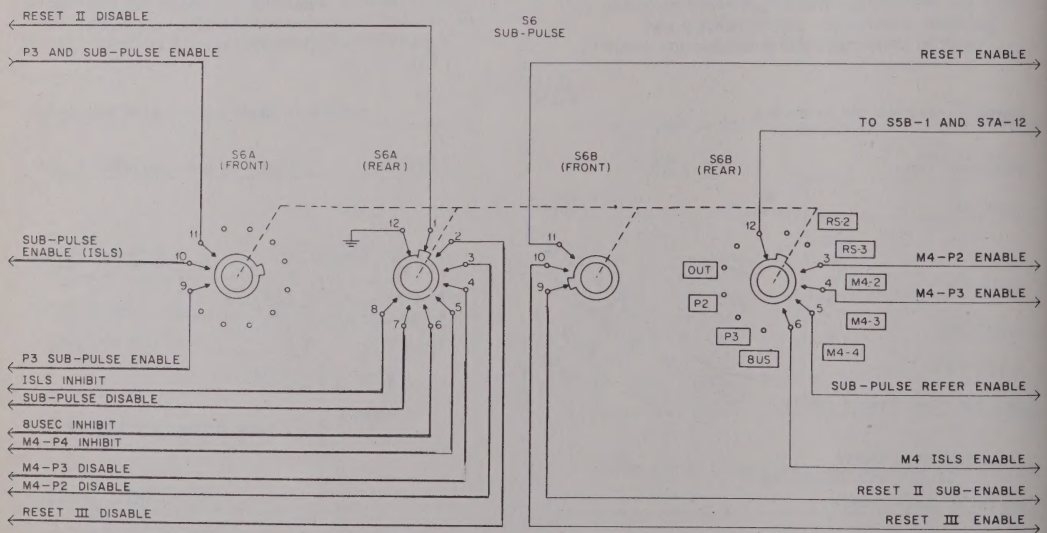
4. SUBSTITUTE PULSE SELECTOR 12S6. – This switch determines the position in the interrogation pulse train into which a substitute pulse will be inserted (figure 4-24).

"OUT" POSITION – All lines connected to 12S6 are disconnected, disabling the sub pulse circuit.

"P2" POSITION – Enabling voltage is applied to switch diodes 12A6CR4 and 12A6CR8, permitting the use of a substitute pulse for the P2 (ISLS) pulse. Applies inhibiting ground to diode 12A6CR7.

"P3" POSITION – Applies disabling ground to switch diodes 12A3CR64 and 12A3CR65 (through 12A1CR68) to prohibit normal IFF P3 pulse generation. Applies enabling voltage to switch diodes 12A3CR55 and 12A3CR56 (through 12A3CR59) to permit use of 2 usec "reference" pulse for generation of a P3 substitute pulse.

"8 usec" POSITION – Applies enabling voltage to switch diodes 12A3CR60 and 12A3CR61 to permit the passage of the P3 ("0 usec") trigger for use as the mode 4 (8-microsecond ISLS) substitute pulse "reference". Also applies enabling voltage (through contacts 6 and 7 of 12S7B rear) to switch diodes 12A1CR16 and 12A1CR21, enabling the substitute pulse delayed trigger. The



REF DESIG PREFIX 12

Figure 4-24. Substitute Pulse Selector Control Circuits, Simplified Schematic Diagram

normal mode 4, 8 usec ISLS pulse is inhibited by the application of a ground to switch diodes 12A3CR74 and 12A3CR75 through 12A3CR76.

"M4 SYNC" (4th) POSITION- Applies enabling voltage to switch diodes 12A3CR55 and 12A3CR56 (through 12A3CR58) to permit the passage of the "2 usec" trigger for use as the mode 4 sync pulse number 4 substitute pulse "reference". Applies disabling ground through 12A3CR73 to switch diodes 12A3CR70 and 12A3CR72 to inhibit the "0" usec normal mode 4 sync pulse number 4.

"M4 SYNC" (3rd) POSITION – Applies enabling voltage to switch diodes 12A3CR47 and 12A3CR48 to permit the passage of the "4 usec" trigger for use as the mode 4 sync pulse number 3 substitute pulse "reference". Applies a disabling ground through diode 12A3CR52 to switch diodes 12A3CR53 and 12A3CR54 to inhibit the "2 usec" normal mode 4 sync pulse number 3.

"M4 SYNC" (2nd) POSITION – Applies enabling voltage to switch diodes 12A3CR36 and 12A3CR37 to permit the passage of the "6 usec" trigger for use as the mode 4 sync pulse number 2 substitute pulse "reference". Applies disabling ground through 12A3CR46 to switch diodes 12A3CR44 and 12A3CR45 to inhibit the "4 usec" normal mode 4 sync pulse number 2.

"RESET" (3rd) POSITION – Contacts of 12S6B connect reset gate from tag gate emitter follower output 12A6Q15 to reset number 3 sub enable line, which applies it to switch diodes 12A3CR33 and 12A3CR34 and 12A3CR23 and 12A3CR24, permitting the "8 usec" and "12 usec" pulses to pass on to the reset substitute trigger line and to the base of sub pulse tag emitter follower 12A1Q11 for the generation of a 4-usec long pulse, located 2 usec ahead of the normal time. Applies a disabling ground to diodes 12A3CR27 and 12A3CR28 to inhibit the normal 3rd reset pulse pair from the "6 usec" and "10 usec" delay line taps.

"RESET" (2nd) POSITION – Contacts of 12S6 connect reset gate from 12A6Q15 to reset number 2 sub enable line, which applies it to switch diodes 12A3CR15 and 12A3CR16 and 12A3CR13 and 12A3CR14, permitting the "15 usec" and "17 usec" pulses to pass on to the reset substitute trigger line and to the base of 12A1Q11 for the generation of a 2 usec long pulse, located 2 usec ahead of the normal time. Applies disabling ground to diodes 12A3CR19 and 12A3CR20 to inhibit the normal 2nd reset pulse pair from the "15 usec" and "13 usec" delay line taps.

5. FUNCTION SELECTOR 12S4. This switch determines the several types and combinations of signals to be supplied by the Interrogation Coder. Its primary function is to select the types of signals to be used in modulating the main rf signal generator on the SM-197A chassis. These include modulating signals from external sources and from the coder and reset pulse circuits of the Interrogation Coder itself. As a secondary function, the selector switches these signals from the rf oscillator to the CODER OUTPUT connector 12J5 for test and monitoring purposes, also making available the ISLS pulses (if in use) at this point. Switch positions are as follows (figure 4-25).

"MOD-HIGH" POSITION – Used when the external modulating signal (at MOD connector 12J3) is between 30 and 50 volts in amplitude. Output of modulation emitter follower 12A1Q18 is routed directly to input of pulse amplifier 12V1. Output of modulator cathode follower 12V3 is routed through 12J6-1 to the main rf oscillator.

"MOD-LOW" POSITION – Used when the external modulating signal is between 5 and 30 volts. Output of modulation emitter follower 12A1Q18 is routed to external blocking oscillator amplifier 12A4Q2 and the output of output emitter follower 12A4Q4 to the input of pulse amplifier 12V1. A ground is connected to the clock inhibit line to prevent interference of clock signals with weak modulation signals. The output of modulator cathode follower 12V3 is fed out through 12J6-1.

"MOD-INT" POSITION – Internally connects the interrogation signal selected by Mode Selector 12S5 to the main rf oscillator. The inhibiting ground is removed from the clock inhibiting line. The output from Output Emitter Follower 12A4Q4 (internal modulating signal) is fed to pulse amplifier 12V1. The output from modulator cathode follower 12V3 is fed out through 12J6-1.

"MOD-MIX" POSITION – Mixed modulating signals including interrogation, reset, substitute

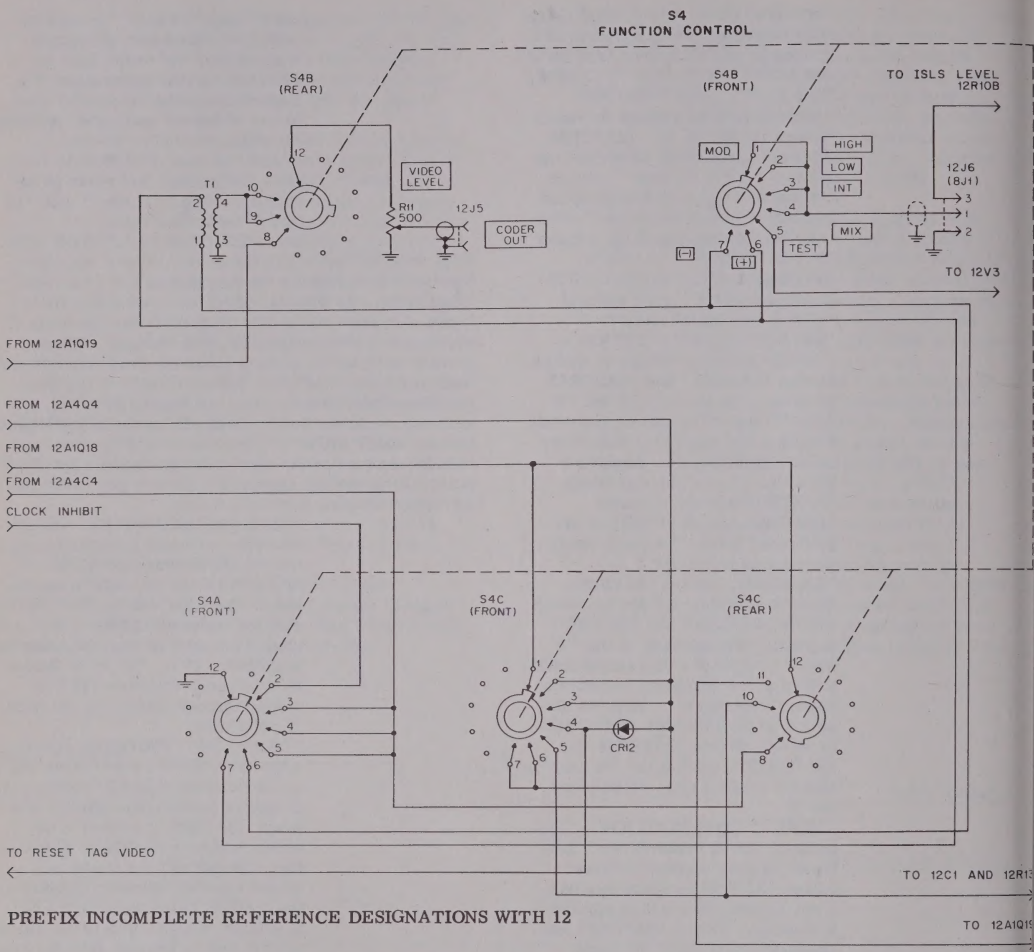


Figure 4-25. Function Selector Control Circuits, Simplified Schematic Diagram

pulses, and external modulating signals (such as SIF) are made available for modulating the main rf oscillator. The output from modulation emitter follower 12A1Q18 is connected to pulse amplifier 12V1 (through CODE LEVEL control 12R12) along with the reset "tag" video from 12A6Q22. Also, the output of output emitter follower 12A4Q4 (internal modulation) is fed to 12V1. The output of modulator cathode follower 12V3 is fed out through 12J6-1.

"TEST" POSITION – Composite video signal from output emitter follower 12A1Q19 is routed to the CODER OUT connector through VIDEO LEVEL control 12R11 for test purposes. No connection is made to 12V1 and no output is connected to 12J6. External modulating signal from modulation emitter follower 12A1Q18 is connected to output emitter follower 12A1Q19.

"(+)" POSITION – Makes available positive-going signal to CODER OUT connector 12J5. Connects output emitter follower 12A4Q4 to 12V1 input. Connects ground to terminal 1 of transformer 12T1 primary. Connects

signal from 12V3 to terminal 2 of transformer T1 primary, providing a positive output at 12J5.

"(-)" POSITION – Same as "(+)", but ground and signal connections reversed on 12T1, giving negative output at 12J5.

6. TYPICAL CONTROL SETTING.- As an example, the Interrogator Coder controls will be described as set up to simulate an interrogation in mode 4, using an ISLS (8 usec) pulse, for which a variable-position pulse will be substituted. Controls will be set as follows:

Step 1. Mode Selector 12S5 is set to the M4 SYNC position to obtain the four mode 4 synchronizing pulses. (Mode 4 information pulses are not produced internally). Switch section 12S5A places a +12 volt enabling potential on the diodes which act as switches between the "0" delay line tap and the P3 trigger out line and on the diodes acting as switches between the "2 usec" tap, the "4 usec" tap, and the "6 usec" tap and the P1 trigger out line. This provides the four normal mode 4 synchronizing pulses. 12S5B places a +12 volt enabling potential on the sub pulse ISLS trigger enable line and also makes it available to the contacts of ISLS Selector 12S7. 12S5 also removes the disabling voltage from the switch diode 12A3CR69 in the "0 usec" reference line.

Step 2. ISLS Selector 12S7 is set to the 8 usec position to obtain the mode 4 ISLS pulse. Switch section 12S7C applies +300 volts to the ISLS circuits. 12S7A ties the 8 usec enable line to the contacts of Substitute Pulse Selector 12S6B and Mode Selector 12S5B. Switch section 12S7B ties the 8 usec enable line to the Sub ISLS trigger enable line.

Step 3. Substitute Pulse Selector 12S6 is set to the 8 usec position to remove the normal 8 usec pulse and substitute a variable-position pulse. Switch section 12S6B ties the sub pulse enable line to the contacts of 12S5B and 12S7A which connect it to the 8 usec enable line. 12S6A puts a disabling ground on the 8 usec disable line, "turning off" the diodes which act as switches between the -2 usec tap and the ISLS trigger line and thus removing the normal ISLS pulse. 12S6A also puts a ground on the sub pulse disable line (for "no disable").

(f) POWER SUPPLY.- A separate power supply section in the Interrogation Coder furnishes the regulated +12 volt and +25 volt collector potentials and the -12 volt emitter potential required by the Interrogation Coder transistor circuits. Figure 4-26 is a simplified schematic diagram of this power supply.

1. INPUT POWER.- The Interrogation Coder power supply requires inputs of 6.3 volts ac and -30 volts dc which are obtained from the power supply section of the SM-197A chassis.

2. POSITIVE 25 VOLT REGULATED SUPPLY.- The 6.3 volt ac input power is applied to the primary of step-up transformer 12T2. The output from the secondary of 12T2 is full-wave rectified by diodes 12CR9 and 12CR10, then filtered by capacitors 12C10, 12C11, and 12C12. The filtered current is passed through +25V series regulator transistor 12Q1 to the +25 volt output. Variations in output voltage due to load variations will appear across the voltage divider consisting of 12R23, 12R24, and 12R25, and are "sensed" by regulator amplifier 12Q2. Voltage regulation is with respect to the reference voltage established by reference Zener diode 12VR2. The nominal output voltage is set by means of +25 V adjust potentiometer 12R24. The variations in 12Q2 collector voltage resulting from load changes are applied to the base of series regulator 12Q1, causing corresponding changes in the amount of voltage dropped and thus compensating for load voltage variations.

3. POSITIVE 12 VOLT REGULATED SUPPLY.- This voltage is taken from the +25 volt regulated output line. Further regulation is provided in the +12 volt branch by means of the voltage divider comprised of resistors 12R26, 12R32, and 12R33, Zener diode 12VR3, and +12V series regulator 12Q3, which function in a manner similar to that of the +25 volt regulator circuit to compensate for output voltage variations. Nominal output voltage is set by +12 Volt Adjust potentiometer 12R32.

4. NEGATIVE 12 VOLT SUPPLY.- The -12 volt potential is obtained from a voltage divider consisting of resistor 12R27 and Zener diode 12VR4 across the main-30 volt line. Since little current is drawn from this line, the Zener diode provides sufficient regulation. Filtering is provided by capacitor 12C16.

(2) CALIBRATION-CONTROL UNIT.- As shown in the block diagram, figure 4-27, the ALC rectifier output is fed through connector 9P1-11 to input integrator diode 9CR1. The partially integrated output signal is amplified by first video amplifier 9V1A, second video amplifier 9V1B, and third video amplifier 9V2A. (Waveforms for the Calibration-Control unit are given in figure 4-28. Voltage readings are given in table 4-2 and resistance readings are given in table 4-3.) The amplified ALC signal is applied to the input of cathode follower 9V3A which serves as a low impedance driver for final integrator diode 9CR2. The integrator output signal is amplified by dc amplifier 9V2B and applied to clamper diode 9CR3 and to the input of ALC output tube 9V3B. The dc output voltage developed by 9V3B is proportional to the peak pulse amplitude of the signal generator and is used in the modulator section for automatic level control. The ALC circuit maintains the output of the signal

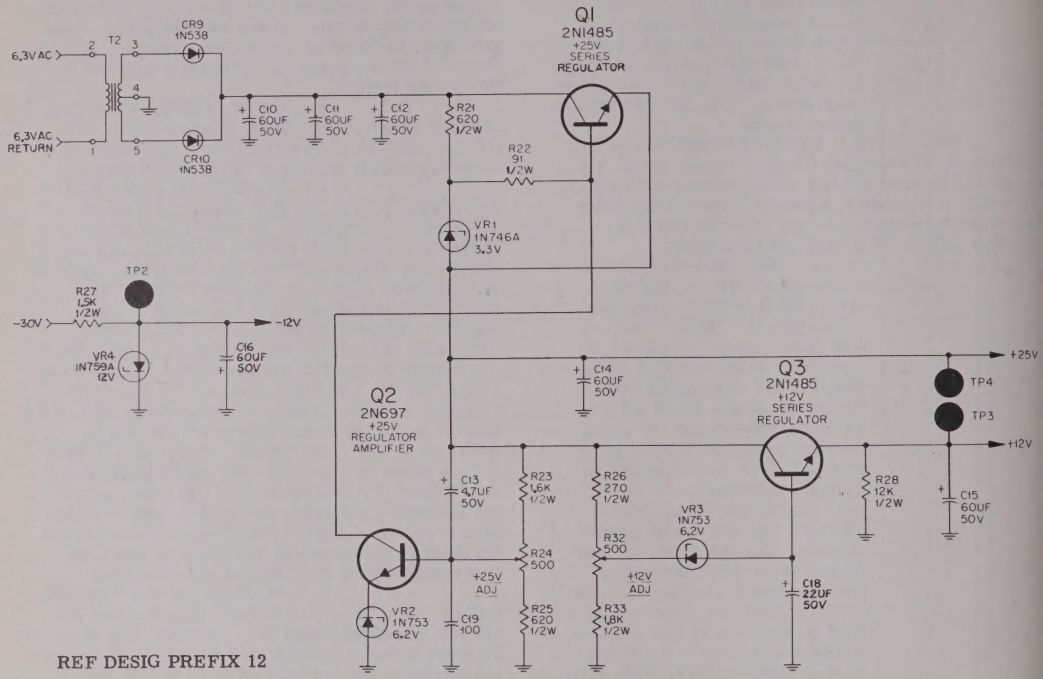


Figure 4-26. Interrogation Coder Power Supply, Simplified Schematic Diagram

TABLE 4-2. CALIBRATION-CONTROL UNIT VOLTAGE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
9V1	+34	+7.5	+7.8	0	0	+44	0	+1.2	FIL
9V2	+49	+0.9	+32	0	0	+92	+1.9	+7.8	+6
9V3	+300	0	+19	FIL	FIL	+300	+93	+107	FIL
9V4	-21	NC	0	FIL	0	NC	+103	--	--
9V5	+195	-5	+16	0	0	+10	+5.6	FIL	+155
9V6	+18	-0.4	+38	0	FIL	+41	+0.2	0	+0.2
9V7	+102	0	+6.6	0	0	+30	0	+1.3	FIL

NOTES: 1. Voltage measurements taken using an electronic multimeter with unit removed but connected with a service cable.

2. All panel controls in ccw position.

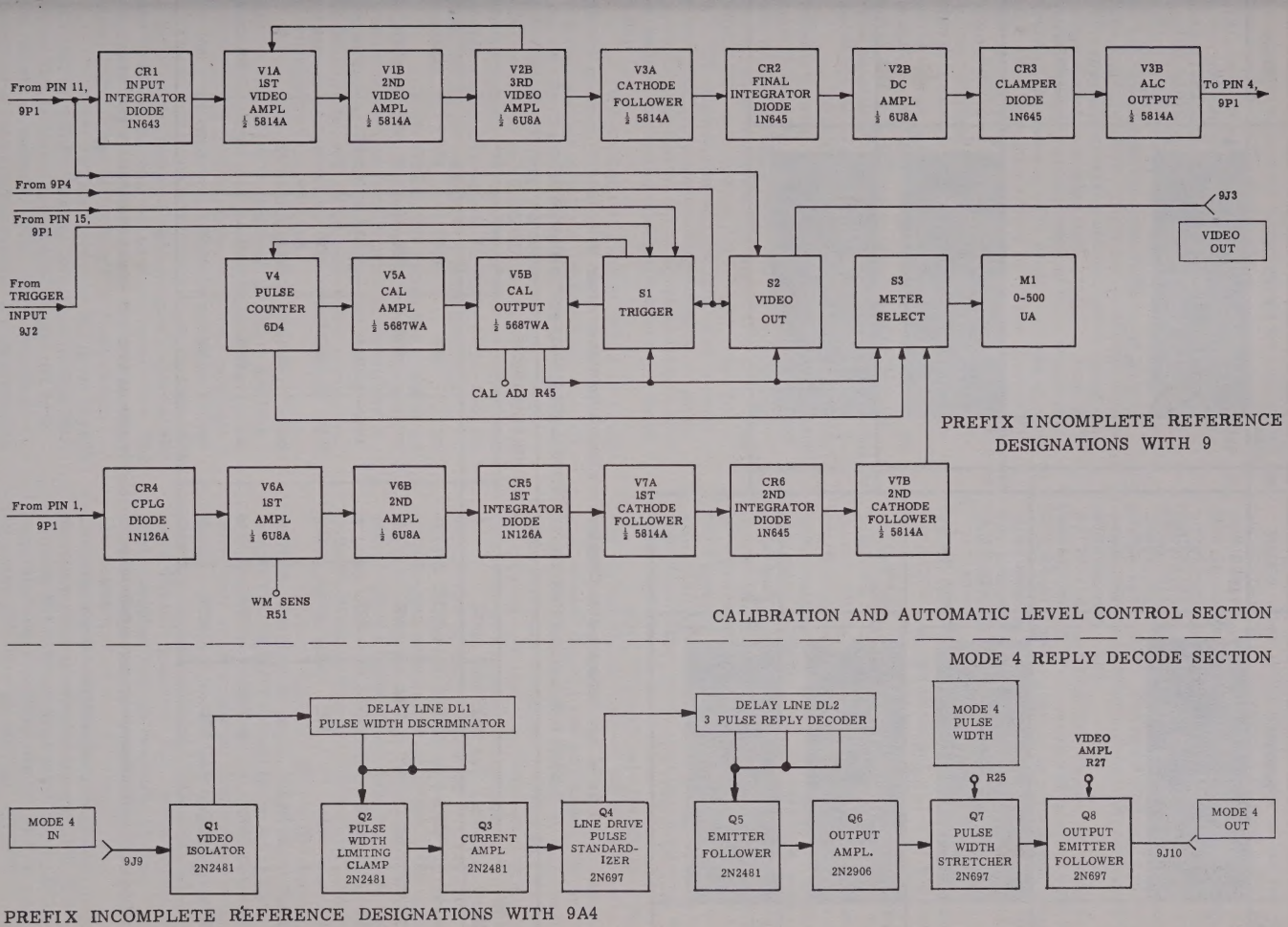


Figure 4-27. Calibration-Control Unit, Block Diagram

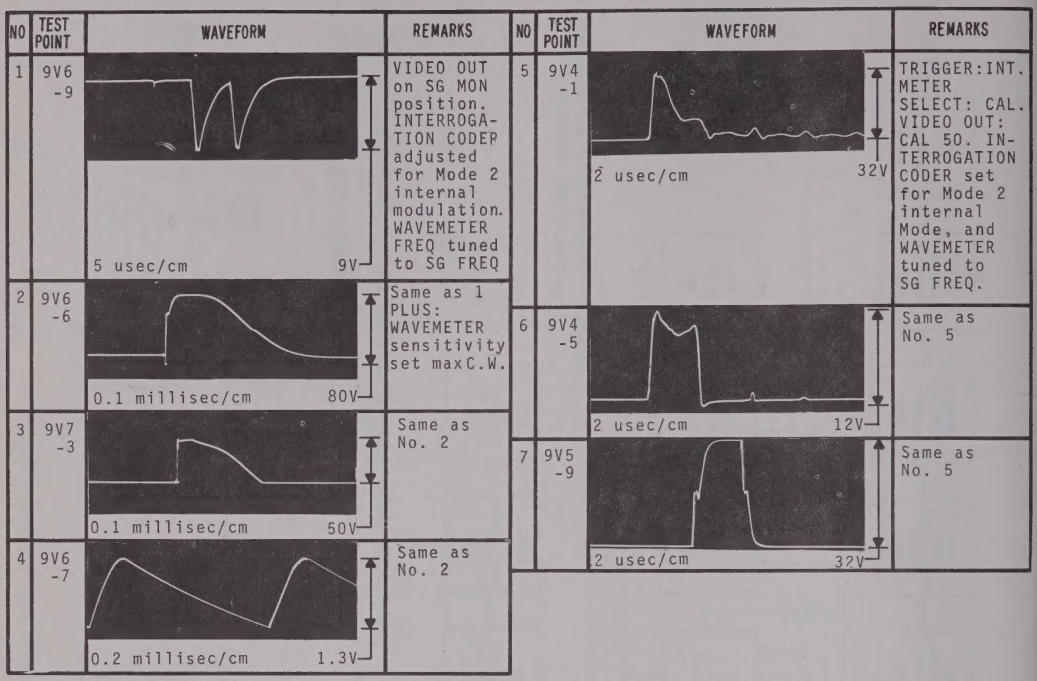


Figure 4-28. Calibration-Control Unit Waveforms

TABLE 4-3. CALIBRATION-CONTROL UNIT RESISTANCE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
9V1	60K	80K	2.3K	∞	∞	60K	400K	850	∞
9V2	62K	1 Meg	13K	∞	∞	300K	620	2.2K	900K
9V3	900K	400K	22K	∞	∞	90K	16K	58K	∞
9V4	60K	NC	∞	∞	380	NC	75K	--	--
9V5	1.7K	∞	480	∞	∞	480	36K	∞	100K
9V6	85K	1 Meg	140K	∞	∞	65K	100	0	8K
9V7	22K	70K	22K	∞	∞	18K	650K	∞	∞

NOTES: 1. Resistance measurements taken to chassis ground with unit removed and disconnected.

2. All panel controls in ccw position.

generator at a constant level over the frequency range of 925 to 1225 megahertz.

When METER SELECT switch 9S3 is set to the WM position, wavemeter measurements can be made regardless of the settings of TRIGGER selector 9S1 and VIDEO OUT switch 9S2. The output of the wavemeter detector is fed through connector 9P1-1 and coupling diode 9CR4 to the input of first amplifier 9V6A. First and second amplifiers 9V6A and 9V6B provide sufficient output signal amplitude to properly drive first integrator diode 9CR5. The partially integrated output of 9CR5 is applied to first cathode follower 9V7A which functions as a low impedance driver for second integrator diode 9CR6. The integrated dc output is applied to second cathode follower 9V7B. The output from second cathode follower 9V7B is applied to meter 9M1 through METER SELECT switch 9S3. Wavemeter detector output voltage is at maximum and current is at a minimum at the wavemeter resonance frequency, so meter 9M1 will indicate a current minimum. WM SENS control 9R51 adjusts the circuit gain to give a meter indication at a convenient level.

When VIDEO OUT switch 9S2 is set to the POWER position, the demodulated output is available regardless of the settings of TRIGGER selector 9S1 and METER SELECT switch 9S3. The demodulated (video) output is supplied through connector 9P4 and VIDEO OUT switch 9S2 to VIDEO OUT connector 9J3. The circuit constants for this output provide proper peak pulse amplitude response for rf pulse power measurements, but do not maintain true pulse shape (see Calibration-Control waveforms in figure 4-28).

When VIDEO OUT switch 9S2 is set to the SHAPE position, demodulated output is available regardless of the settings of TRIGGER selector 9S1 and METER SELECT switch 9S3. Demodulated output is supplied through connector 9P4 and VIDEO OUT switch 9S2 to VIDEO OUT connector 9J3. The circuit constants for this output provide proper frequency and phase response for pulse shape observation, but do not maintain true pulse amplitude response.

When VIDEO OUT switch 9S2 is set to the SG MON position, the demodulated output is available for signal generator monitoring regardless of the settings of TRIGGER selector 9S1 and METER SELECT switch 9S3. This video output is supplied through connector 9P1 and VIDEO OUT switch 9S2 to VIDEO OUT connector 9J3.

When TRIGGER selector 9S1 is set to INT and METER SELECT switch 9S3 is set to 500 PRF, meter 9M1 indicates the internal trigger pulse repetition frequency (prf) in pulses per second (pps) up to the full scale reading of 500. The setting of VIDEO OUT switch 9S2 has no effect on this test function. The internal trigger signal is supplied from connector 9P1 and TRIGGER selector 9S1 to pulse counter 9V4. The integrated output of pulse counter 9V4 is applied to meter 9M1 through METER SELECT switch 9S3.

When TRIGGER selector 9S1 is set to INT and METER SELECT switch 9S3 is set to 5000 PRF, meter 9M1 indicates the internal trigger prf up to the full scale reading of 5000. The principle of operation is basically the same as that described in the preceding paragraphs.

When TRIGGER selector 9S1 is set to EXT and METER SELECT switch 9S3 is set to 500 PRF, meter 9M1 indicates external trigger prf up to the full scale reading of 500. The setting of VIDEO OUT switch 9S2 has no effect on this test function. The external trigger signal is supplied through TRIGGER INPUT connector 9J2 and TRIGGER selector 9S1 to pulse counter 9V4. The integrated output of pulse counter 9V4 is applied to meter 9M1 through METER SELECT switch 9S3.

When TRIGGER selector 9S1 is set to EXT, and METER SELECT switch 9S3 is set to 5000 PRF, meter 9M1 indicates the prf of any external trigger input up to the maximum full scale reading of 5000. The principle of operation is basically the same as that described in the preceding paragraphs.

When TRIGGER selector 9S1 is set to INT, VIDEO OUT switch 9S2 is set to 50, and METER SELECT switch 9S3 is set to CAL, a 50-volt calibration pulse output is made available. The internal trigger signal is supplied through connector 9P1 and TRIGGER selector 9S1 to pulse counter 9V4. Pulse counter 9V4 is a gas triode tube which produces a rectangular output pulse regardless of the waveform of the input pulse. This pulse signal is amplified by calibrator amplifier 9V5A and calibrator output tube 9V5B and supplied to VIDEO OUT connector 9J3 through VIDEO OUT switch 9S2. The integrated output signal from calibrator output tube 9V5B is supplied to meter 9M1 through METER SELECT switch 9S3. CAL ADJ control 9R45 is used to adjust the gain of calibrator output amplifier 9V5B for a full scale indication on meter 9M1.

When TRIGGER selector 9S1 is set to INT and METER SELECT switch 9S3 is set to CAL, VIDEO OUT switch 9S2 can be set for the desired peak-to-peak output pulse amplitude. The principle of operation is basically the same as that described in the preceding paragraph. VIDEO OUT switch 9S2 permits the selection of an output level of 50, 10, 5, 2, 1, 0.5, or 0.1 volts, peak-to-peak.

When TRIGGER selector 9S1 is set to EXT and METER SELECT switch 9S3 is set to CAL, VIDEO OUT switch 9S2 can be set for the desired peak-to-peak output pulse amplitude. The external trigger is supplied through TRIGGER INPUT connector 9J2 and TRIGGER selector 9S1 to the input of pulse counter 9V4. The pulse counter and circuits which follow function as described in the preceding paragraphs.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to POWER, and METER SELECT switch 9S3 is set to 5000 PRF, demodulated (video) output is made available and meter 9M1 indicates the prf up to the full scale indication of 5000. Demodulated output is supplied through connector 9P4 and VIDEO OUT switch 9S2 to VIDEO OUT connector 9J3. Demodulated output is also supplied through connector 9P4 and TRIGGER selector 9S1 to the input of calibration output amplifier 9V5B.

The amplified pulse from calibrator output amplifier 9V5B is supplied through TRIGGER selector 9S1 to the input of pulse counter 9V4. The integrated output of pulse counter 9V4 is applied to meter 9M1 through METER SELECT switch 9S3.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to POWER, and METER SELECT switch 9S3 is set to 500 PRF, demodulated output is made available and meter 9M1 indicates the prf up to the maximum full scale reading of 500. Basic operation is the same as that described in the preceding paragraphs.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to SHAPE, and METER SELECT switch 9S3 is set to 5000 PRF, demodulated output is made available and meter 9M1 indicates the prf up to the full scale reading of 5000.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to SHAPE, and METER SELECT switch 9S3 is set to 500 PRF, demodulated output is made available and meter 9M1 indicates the prf up to the full scale reading of 500.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to SG MON, and METER SELECT switch 9S3 is set to 5000 PRF, ALC rectifier video output is made available for monitoring, and meter 9M1 indicates the prf of the demodulator video output up to the full scale reading of 5000. The ALC rectifier video output is supplied through connector 9P1-11 and VIDEO OUT switch 9S2 to VIDEO OUT connector 9J3. Demodulator video output is supplied through connector 9P4-1 and TRIGGER selector 9S1 to the input of calibrator output amplifier 9V5B. The amplified pulse from calibrator output amplifier 9V5B is supplied through TRIGGER selector 9S1 to the input of pulse counter 9V4. The integrated output of pulse counter 9V4 is applied to meter 9M1 through METER SELECT switch 9S3.

When TRIGGER selector 9S1 is set to DEMOD, VIDEO OUT switch 9S2 is set to SG MON, and METER SELECT switch 9S3 is set to 500 PRF, ALC rectifier video output is available for signal generator monitoring and meter 9M1 indicates the demodulator video output prf up to the full scale reading of 500. Basic operation is the same as that described in the preceding paragraph.

(a) ALC CIRCUIT DESCRIPTION.- The circuit of the ALC section is shown in figure 4-29. The negative-going voltage from the ALC rectifier is coupled to the ALC circuit in the Calibration-Control unit through pin 11 of 9P1. This voltage is applied to input integrator diode 9CR1 through capacitor 9C3. The cathode of 9CR1 is set at a positive potential by the voltage divider composed of resistor 9R4 and ALC ADJ potentiometer 9R3. When the negative pulse applied to diode 9CR1 is lower than the bias, no conduction occurs. When the negative input pulse exceeds the bias voltage, diode 9CR1 conducts, charging capacitor 9C4.

When the trailing edge of the negative input pulse falls below the bias level, 9CR1 stops conducting and 9C4 discharges through 9R5 and 9R8. Because 9CR1 presents a high back resistance, the discharge time-constant is greater than the charging time-constant. Thus, the output pulse from capacitor 9C4 is integrated, and is longer in duration than the input pulse to diode 9CR1. The rf oscillator level at which the ALC system operates is established by ALC ADJ potentiometer 9R3 which sets the cathode bias on 9CR1.

The integrated pulse from 9C4 is applied to a three-stage video amplifier consisting of tubes 9V1A, 9V1B, and 9V2A. Negative feedback is used between third video amplifier 9V2A and first video amplifier 9V1A to obtain the required frequency response and stability characteristics. The output from third video amplifier 9V2A is coupled through capacitor 9C8 to the grid of cathode follower 9V3A.

The pulses at the cathode of 9V3A are fed through final integrator diode 9CR2 to charge capacitors 9C11 and 9C12. The voltage at the cathode of 9CR2 is essentially a dc voltage of positive polarity which is applied to the control grid of dc amplifier 9V2B.

A rise in voltage at the grid of 9V2B causes a decrease in the voltage applied to the grid of the ALC output cathode follower 9V3B, which causes a reduction in the voltage at the cathode of 9V3B. Consequently, a lower voltage is fed to the ALC clipper in the Interrogation Coder through terminal 4 of 9P1. Clamper diode 9CR3 prevents the grid of 9V3B from rising above the positive level set by the voltage divider consisting of resistors 9R70 and 9R71.

The internal OPER-CHECK toggle switch 9S4 is accessible from the right side of the Calibration-Control unit. When this switch is in the CHECK position, a fixed positive voltage is applied to the grid of 9V3B which causes the cathode voltage of 9V3B to remain high. This switch is useful for applying a "go-no-go" test to the ALC section.

Capacitive feedback is provided from the output of ALC output tube 9V3B to the input of dc amplifier 9V2B through 9C11 to eliminate "hunting" (spurious oscillation of the output around the desired level).

(b) PULSE COUNTER.- Pulse counter 9V4 counts pulses from any of three sources; pulses from calibrator output tube 9V5B, delayed trigger pulses from the Crystal Mark and Sync unit, or trigger pulses from external equipment. TRIGGER selector 9S1 enables the operator to select any one of these three pulse sources. Pulse repetition frequencies in the ranges of 0-500 and 0-5000 can be measured by using the appropriate position of METER SELECT switch 9S3. Figure 4-30 shows the pulse counter circuit.

Pulse counter 9V4 is non-conducting until an incoming positive pulse is applied to its grid through capacitor 9C13 and TRIGGER selector 9S1A (rear). Upon application of a positive trigger pulse, gas triode 9V4 conducts rapidly, discharging the capacitor connected between 9V4 plate and ground. (When METER SELECT switch 9S3 is in the 5000 PRF position, the capacitor used is 9C30; when 9S3 is in the 500 PRF position, the capacitor used is 9C29.) As the capacitor discharges, the 9V4 plate voltage falls below the level required to maintain ionization, and conduction stops.

When 9V4 stops conducting, the capacitor connected between its plate and ground is recharged from the +105 volt supply through a resistor network. When METER SELECT switch 9S3 is in the 5000 PRF position, the charging network consists of 9R30 and potentiometer 9R31. When 9S3 is in the 500 PRF position, the charging network consists of 9R29 and potentiometer 9R31. A pulse of current flows through meter 9M1 and resistor

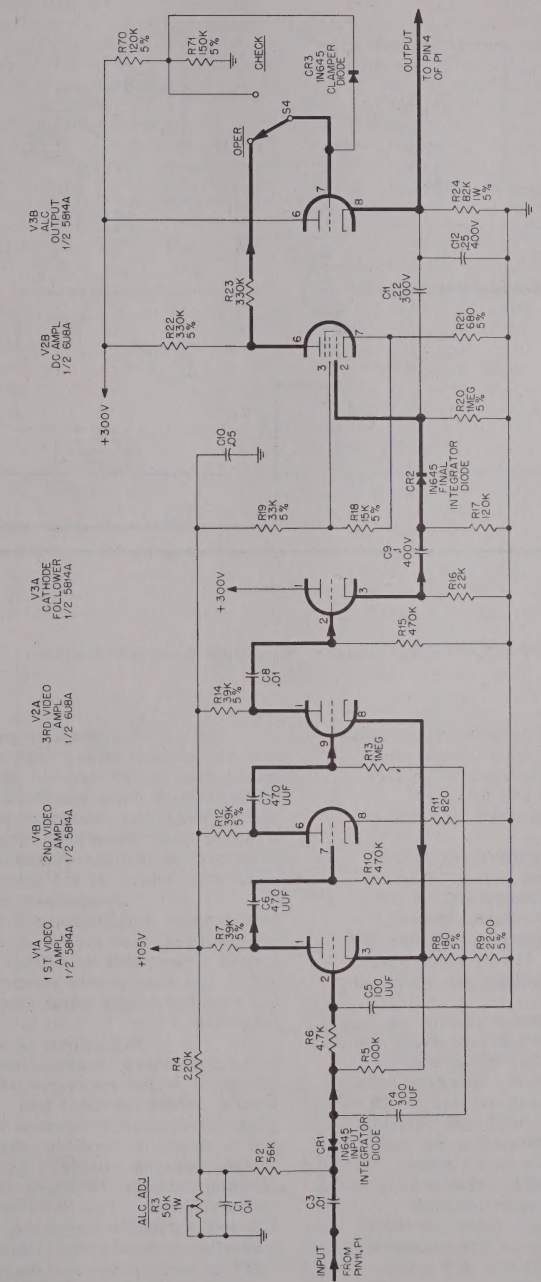


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Figure 4-29. ALC Section, Simplified Schematic Diagram

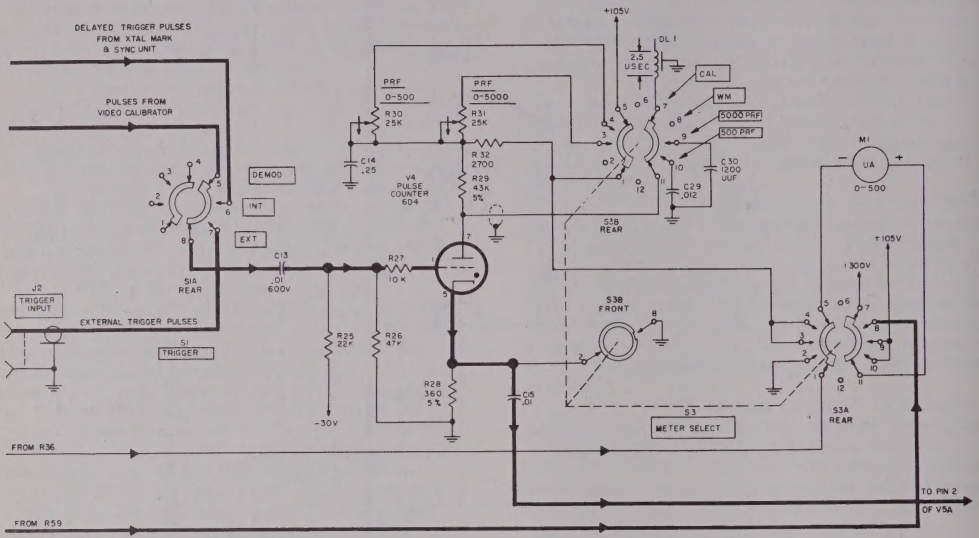

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Figure 4-30. Pulse Counter, Simplified Schematic Diagram

9R32 each time an input trigger pulse fires gas triode 9V4. The average current through meter 9M1 is proportional to the pulse repetition frequency. Potentiometers 9R30 and 9R31 are screwdriver adjusted potentiometers used to calibrate each prf range.

(c) VIDEO CALIBRATOR.- The video calibrator supplies output pulses of known amplitude at VIDEO OUT connector 9J3 on the Calibration-Control unit. The outputs available and the appropriate switch settings are described in paragraph 4-3(b), above. The circuits which produce the video calibrator pulses are shown in figures 4-30 and 4-31.

The video calibrator pulses are generated by pulse counter 9V4 (figure 4-30) and amplified by calibrator amplifier 9V5A and calibrator output amplifier 9V5B. Positive input triggers from the trigger source are fed to the grid of 9V4 through capacitor 9C13 and resistor 9R27, causing 9V4 to fire. When the gas tube fires, a negative pulse appears at its plate. The unterminated delay line 9DL1 causes a reflected pulse to appear 2.5 microseconds later, lowering the plate voltage below the value required to maintain conduction. The conduction period of 9V4 is thus maintained at 2.5 ± 0.5 microseconds for each trigger pulse.

The positive pulses developed across resistor 9R28 in the cathode circuit of pulse counter 9V4 are fed to calibrator amplifier 9V5A through capacitor 9C15. Calibrator amplifier 9V5A and calibrator output amplifier 9V5B provide two stages of amplification and inversion so that the pulses are still positive when they appear at the plate of 9V5B.

The seven different video calibrator pulse amplitudes are obtained by changing the plate load circuit of 9V5B and the output circuit from 9V5B to VIDEO OUT receptacle 9J3. The components comprising these circuits for each calibrator pulse amplitude are listed in table 4-4.

Regardless of which of the seven pulse amplitudes is used, meter 9M1 gives an indication of the measured amplitude of the pulses. Resistor 9R35 and capacitor 9C28 perform an integrating function for the meter so that a steady dc level is read. For the 50-volt pulses, peaking coil 9L2, peaking coil 9L3, and damping resistor 9R72 are used to preserve the waveshape. For the 1-volt, 0.5 volt, and 0.1 volt pulses, a voltage divider consisting of precision resistors 9R47, 9R64, 9R65, and 9R66 is used across the output of 9V5B, with a dc blocking capacitor 9C27 in series with the

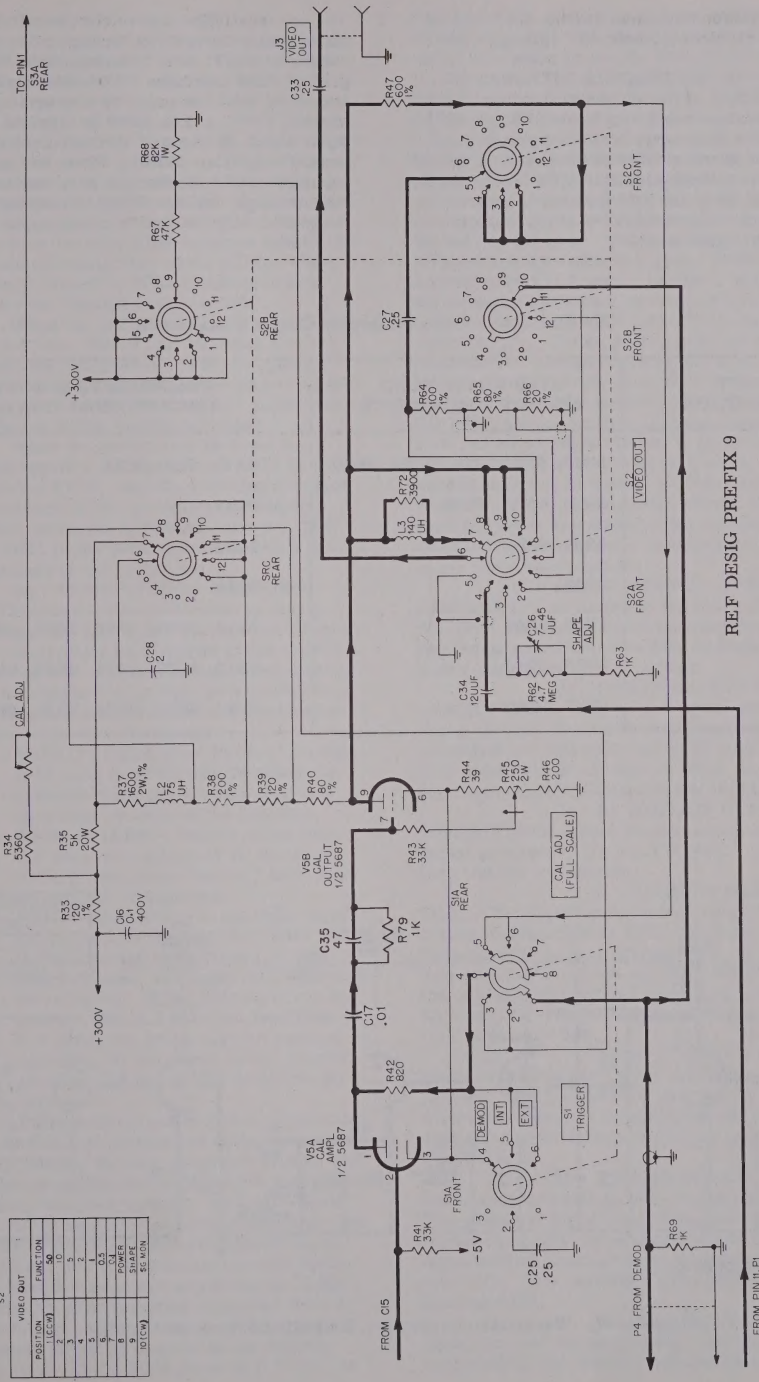

Figure 4-31. Calibrator Amplifier, Simplified Schematic Diagram

circuit. All video calibrator pulses are coupled to the VIDEO OUT receptacle 9J3 through capacitor 9C33.

(d) WAVEMETER INTEGRATOR.- The rectified output of the wavemeter is applied to an integrator circuit containing tubes 9V6 and 9V7. The output of the final stage of the integrator provides indication of wavemeter resonance by a meter connected in the cathode circuit. METER SELECT switch 9S3 must be in the WM position for wavemeter operation. The wavemeter integrator circuit is shown in figure 4-32.

The wavemeter negative polarity output pulse is applied through pin 1 of 9P1, capacitor 9C18, and coupling diode 9CR4 to the grid of first amplifier 9V6A which produces an amplified positive pulse at the arm of WM SENS control 9R51. This pulse is applied to capacitor 9C20 which is charged through grid conduction of second amplifier 9V6B. When the pulse decays, capacitor 9C20 discharges at a relatively slow rate through resistor 9R52, resulting in an integrated negative pulse being applied to the grid of 9V6B.

TABLE 4-4. Video Calibrator Circuit Components

VIDEO OUT SWITCH POSITION	9V5B PLATE LOAD CIRCUIT COMPONENTS	COMPONENTS IN OUTPUT CIRCUIT FROM 9V5B to 9J3
50	9R37, 9L2, 9R38, 9R39, 9R40	9R72, 9L3, 9C33
10	9R38, 9R39, 9R40	9C33
5	9R39, 9R40	9C33
2	9R40	9C33
1	9R39, 9R40	9R47, 9C27, 9R64, 9R65, 9R66, 9C33
.5	9R39, 9R40	9R47, 9C27, 9R64, 9R65, 9R66, 9C33
.1	9R39, 9R40	9R47, 9C27, 9R64, 9R65, 9R66, 9C33

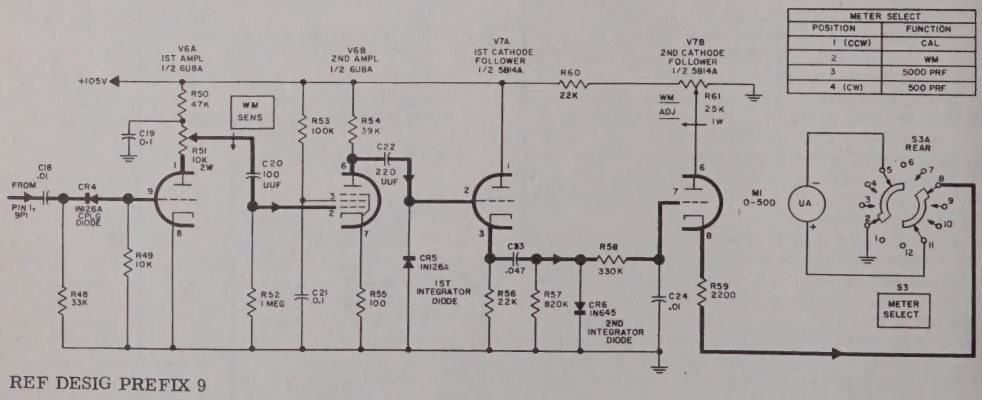

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Figure 4-32. Wavemeter Integrator, Simplified Schematic Diagram

The negative integrated pulse applied to 9V6B grid produces an extended waveform of positive polarity at 9V6B plate and first cathode follower 9V7A grid. The discharge of capacitor 9C22 in the grid circuit further extends the pulse duration and tends to make the grid of 9V7A go negative. This is prevented by first integrator diode 9CR5 which clips the negative portion of the pulse and effectively increases the positive portion, resulting in added sensitivity. Further integration of the positive pulse takes place in the cathode circuit of 9V7A. The positive voltage across resistor 9R56 charges capacitor 9C23 through second integrator diode 9CR6. When the pulse decays, capacitor 9C23 discharges at a relatively slow rate through resistor 9R57.

When the METER SELECT switch 9S3 is in the WM position, meter 9M1 is connected between 9V7B cathode and ground. WM ADJ potentiometer 9R61 permits adjustment of the plate voltage of 9V7B so that meter 9M1 indicates full scale with zero signal applied to the wavemeter input.

When the wavemeter is tuned to resonance, the negative voltage across 9R57 is applied to the grid of 9V7B, thereby reducing its plate current. Resonance of the wavemeter is reached when meter 9M1 indicates minimum current. WM SENS control 9R51 in the plate circuit of 9V6A controls the magnitude of the meter dip.

(e) MODE 4 REPLY DECODING CIRCUITS. - This function is performed by Reply Decoder Subassembly 9A4 in the Calibration-Control Unit which is electrically independent of the rest of the circuits in the unit. This transistorized circuit (figure 4-33) is designed to provide pulse width discrimination and sharp rejection characteristics for pulse position errors as listed below:

NARROW PULSES — Pulses less than 0.25 usec in width will definitely be rejected while pulses less than 0.3 usec may or may not be rejected.

WIDE PULSES — Pulses wider than 0.8 usec will definitely be rejected while pulses more than 0.7 usec may or may not be rejected.

PULSE SPACING — If the pulse spacing error between the first pulse and the second and third pulses is less than 0.2 usec, the group will definitely be accepted. If the spacing error is greater than 0.2 usec but less than 0.4 usec, the group may or may not be rejected. If the error is 0.4 usec or greater, the group will definitely be rejected.

Pulse width discrimination is provided by delay line 9A4DL1 in conjunction with pulse width limiting clamp 9A4Q2, current amplifier 9A4Q3, and line drive pulse standardizer 9A4Q4. The delay line assembly drives two diode groups, the three-diode AND gate providing rejection of pulses narrower than 0.3 usec, and the six-diode AND gate providing an output if the pulses are 0.65 usec or more in width. Pulses wider than 0.3 usec are amplified by 9A4Q3 and coupled via the differentiating capacitor 9A4C2 to the base of 9A4Q4. For pulses of normal width this narrow pulse output is coupled to the decode delay line 9A4DL2. If the input pulse is 0.7 usec or more in width, the input into the 9A4Q3 base from 9A4Q2 will "kill" the 9A4Q3 output, preventing the output of a pulse to decode delay line 9A4DL2.

Pulse group decoding is accomplished by means of a passive delay line 9A4DL2 and by coincident pulse detection. The narrow (approximately 0.3 usec) pulse output of line drive pulse standardizer 9A4Q4 is employed directly as delay line drive with pulse width (and potential coincidence zone) expansion provided by pairs of taps at the 1.73 usec and 1.86 usec and the 3.56 and 3.69 usec time positions feeding into an OR gate. This provides a narrow slot reference and an effective pulse width at the taps of approximately 0.4 usec. Isolation of the delay line tap outputs is provided by emitter follower 9A4Q5. Output amplifier 9A4Q6 is the final stage of the decoder proper. Pulse width stretcher 9A4Q7 acts to increase the nominal 0.15 to 0.2 usec decode input to the specified nominal value of 0.5 usec. Pulse width may be adjusted by means of Pulse Width control 9A4R25. Output emitter follower 9A4Q8 provides buffered output signal to low impedance loads (70 ohms nominal) at levels up to 5 volts. Output level may be adjusted by means of Video Amplitude Control 9A4R27. This pulse decoder circuit may be used for such purposes as making a "go-no-go" check of demodulated transponder outputs and the processing of receiver video outputs.

(3) SM-197A PANEL-CHASSIS ASSEMBLY. - As shown in the block diagram of the SM-197A Panel-Chassis Assembly (figure 4-34), the two functional sections in this assembly are the power supply and the rf section.

(a) POWER SUPPLY GENERAL DESCRIPTION. - The power supply section of the Panel-Chassis Assembly furnishes regulated plate potentials of +300 volts and +105 volts, regulated bias potentials of -30 and -5 volts, and 6.3 volt filament potentials to Coder Simulator SM-197A/UPM-98.

(b) RF SECTION GENERAL DESCRIPTION. - This section contains the main rf signal generator, the ALC rectifier, the demodulator, and the wavemeter.

1. MAIN RF SIGNAL GENERATOR. - The signal generator produces a signal by means of rf oscillator 8V2, which is modulated by the pulses brought in through 8J1. The output amplitude is adjusted by the ATTENUATION control and the output frequency is adjusted by the SG FREQUENCY control. The pulsed rf output is available at SG OUT connector 8J6.

2. ALC RECTIFIER. - ALC rectifier 8V1 is part of the automatic level control system. The pulsed rf output of 8V2 is fed to 8V1 where the signal is demodulated and then fed to the automatic level control amplifier in the Calibration-Control unit.

3. DEMODULATOR. - The demodulator converts pulsed rf signals to video pulses. The pulsed rf signal can be supplied either from external equipment or internally from 8V2. The demodulating function is performed by demodulator tube 8V3. The resulting video pulses are brought out through 8J18.

4. WAVEMETER. - The wavemeter is used for accurate measurement of the frequency of the signal produced internally or of

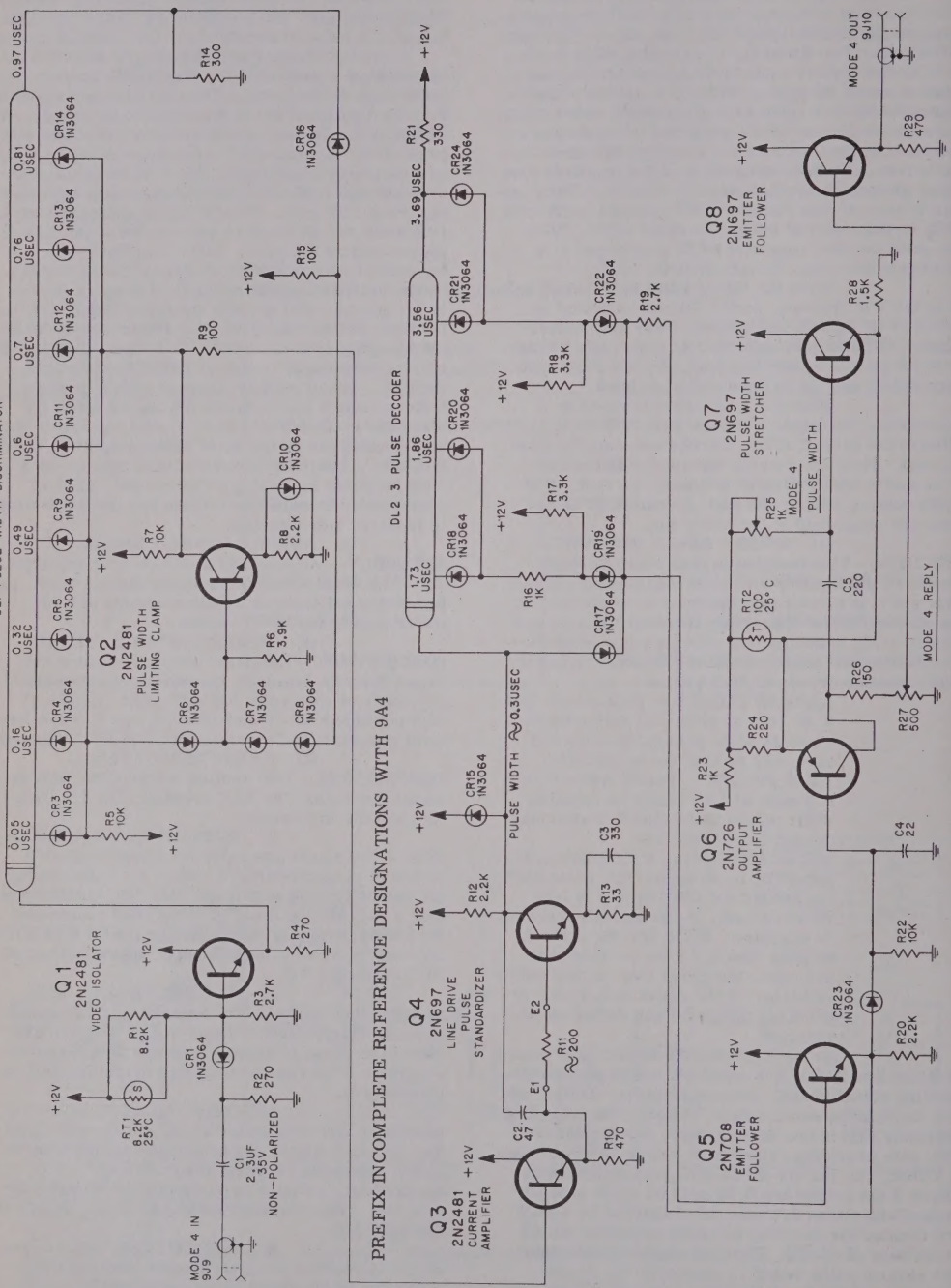

Figure 4-33. Mode 4 Reply Decode Circuit, Simplified Schematic Diagram

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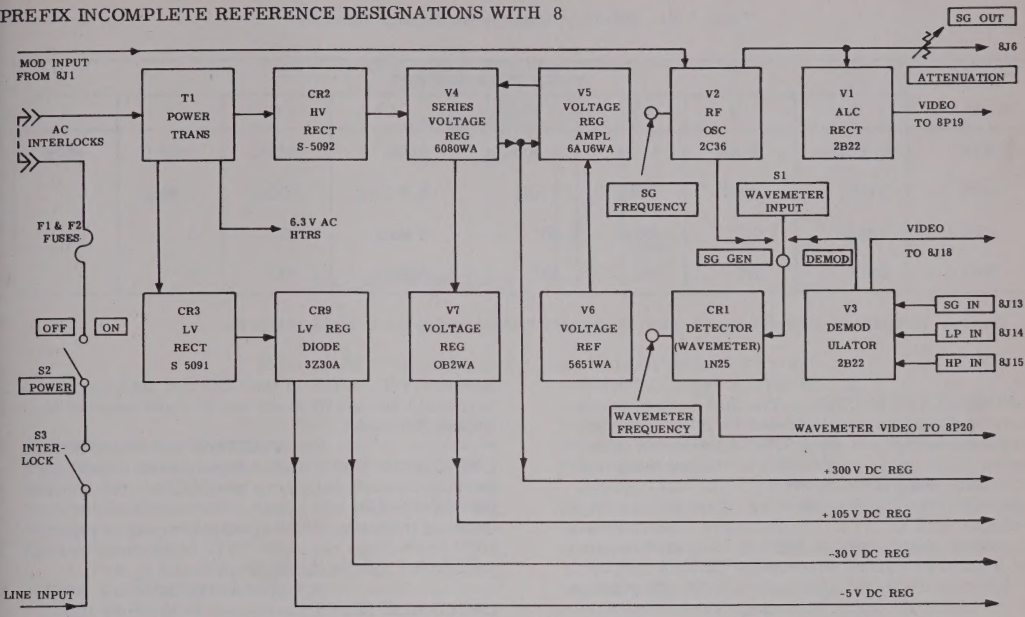


Figure 4-34. SM-197A/UPM-98 Panel-Chassis Assembly, Block Diagram

signals from an external source. The wavemeter tuning is adjusted by means of the WAVEMETER FREQUENCY control. When the modulated rf signal from the modulator is to be measured, it is fed to the demodulator from where a sample is fed to the Calibration-Control unit. Wavemeter resonance is indicated by a meter needle dip on the Calibration-Control meter.

(c) POWER SUPPLY CIRCUIT DESCRIPTION. - The power supply section on the SM-197A Panel-Chassis Assembly furnishes regulated plate potentials of +300 volts and +105 volts, regulated bias potentials of -30 and -5 volts, and 6.3 volt ac filament potentials for all circuits in Coder Simulator SM-197A/UPM-98. This power supply is shown in the overall panel-chassis schematic diagram (figure 5-64). Table 4-5 shows voltage measurements and table 4-6 shows resistance measurements taken on the SM-197A power supply.

1. LINE INPUT. - Primary power is brought in through 8P21, interlock switch 8S3, POWER switch 8S2, fuses 8F1 and 8F2, and the ac interlocks located in the Calibration-Control and Interrogation Coder units. (See figure 5-64 for the detailed ac power distribution.) The primary power is then applied to transformer 8T1.

Table 4-5. SM-197A Chassis Voltage Readings

TUBE NO.	TUBE PIN NUMBERS							
	1	2	3	4	5	6	7	8
8V4	+262	+403	+302	+262	+403	+302	Fil	Fil
8V5	+8	NC	NC	NC	+105	NC	0	--
8V6	+83	NC	NC	NC	+83	NC	0	--
8V7	+105	NC	NC	NC	+105	NC	0	--

NOTE: Voltage measurements taken with plug-in units connected.

Table 4-6. SM-197A Chassis Resistance Readings

TUBE NO.	TUBE PIN NUMBERS							
	1	2	3	4	5	6	7	8
8V4	5.2 Meg	550K	500K	3.5 Meg	550K	520K	490K	490K
8V5	250K	250K	500K	500K	5.5 Meg	550K	2 Meg	--
8V6	2 Meg	NC	NC	NC	2 Meg	NC	0	--
8V7	600K	NC	NC	NC	600K	NC	0	--

NOTE: Resistance measurements taken to chassis ground with plug-in units removed.

2. POSITIVE 300 VOLT REGULATED PLATE SUPPLY. - The high voltage secondary of 8T1 at terminals 10 and 11 is rectified by full-wave bridge rectifier 8CR2 and filtered by inductor 8L11 and capacitor 8C18. Figure 4-35 is a schematic diagram showing the filter and regulator circuits. The filtered output is connected to series voltage regulator 8V4 and then to the +300 volt load. Regulator shunt resistor 8R29 is connected in parallel with 8V4 to carry a portion of the load current and reduce the plate dissipation of 8V4. Regulation of the +300 volt supply is accomplished by voltage regulator amplifier 8V5, voltage reference 8V6, and series voltage regulator 8V4. The +300 V ADJ potentiometer 8R35 sets the nominal level of the output voltage. The voltage drop across 8V4 is determined by the magnitude of the nominally +300 volt output. A regulating action is performed since a voltage rise causes an increased voltage drop across 8V4 and tends to restore the +300 volt output to its former level. A fall in the +300 volt output causes a decreased voltage drop across 8V4 and tends to increase the output.

3. POSITIVE 105 VOLT REGULATED PLATE SUPPLY. - Figure 4-35 shows that the same circuit is used to provide the +105 volt output and the +300 volt output. The +105 volts is obtained from the +300 volt output through resistor 8R37 and voltage regulator 8V7. Regulation to compensate for load variation is provided by 8V7.

4. NEGATIVE 30 VOLT REGULATED BIAS SUPPLY. - Figure 4-36 shows the circuit used to obtain this regulated voltage. The current from a low voltage winding of transformer 8T1 is rectified by 8CR3 and filtered by the network consisting of resistor 8R19 and capacitor 8C15. The -30 volt output is regulated by resistor 8R20 and Zener diode 8CR9. Capacitor 8C16 bypasses to ground the noise generated by 8CR9.

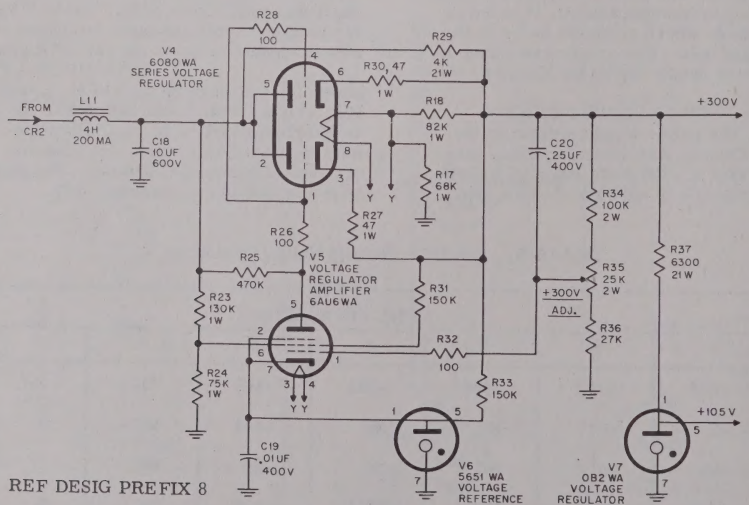


Figure 4-35. SM-197A Voltage Regulators, Simplified Schematic Diagram

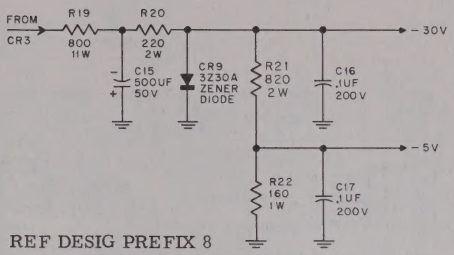


Figure 4-36. Bias Regulator, Simplified Schematic Diagram

5. NEGATIVE 5 VOLT SUPPLY.- This voltage is obtained through a voltage divider on the -30 volt output consisting of resistors 8R21 and 8R22 (figure 4-36). Only a very slight current is drawn from this network so the -5 volt output is relatively stable. Capacitor 8C17 bypasses to ground the noise generated by 8CR9.

(d) RF SECTION CIRCUIT DESCRIPTION. - This section contains RF Oscillator Assembly 8A1, ALC Attenuator Assembly 8A2, Demodulator Assembly 8A4, Wavemeter Assembly 8A3, WAVEMETER INPUT switch 8S1, Directional Coupling 8A9, and the associated rf plumbing. Refer to figure 5-64 for the overall schematic diagram covering this section.

1. RF OSCILLATOR. - Rf oscillator 8V2 is a type 2C36 planar triode tube in a tuned plate, tuned cathode circuit. Its construction is shown in figure 4-37. The tuning elements are one-quarter wave-length coaxial lines tuned by shorting plungers. For purposes of compactness, the cathode line is arranged inside, and concentric with, the plate line. The frequency can be varied from 925 to 1225 megahertz by changing the position of the shorting plungers. The oscillator is capable of responding to the short pulse duration and pulse spacing of the modulating pulse train from the SIF Coder. The feedback required to maintain oscillation is provided by a built-in feedback probe in the 8V2 tube plus an external feedback probe. These probes enable the oscillator to respond within the short time interval required for SIF Coder modulation.

The type 2C36 tube used is designed as a zero-bias pulsed oscillator. It operates in this capacity with only the pulse modulation voltage applied to its plate. The rf oscillator has two electrostatic output coupling probes, one for coupling to the wavemeter, and the other for coupling to ALC rectifier 8V1 and the output-attenuator waveguide.

Filters and shields are used to confine the radio frequency energy to the coaxial lines feeding the wavemeter and the output circuits. The oscillator plate connection has filter 8Z1 installed at the entrance to the line. The plate end of the oscillator tube is shielded by a removable threaded cap. The tube filament is fed through filter 8Z3 from the 6.3 volt ac source. Leakage through the plunger actuating rods is eliminated by means of the back shield and the rod shorting fingers.

2. ALC RECTIFIER. - ALC Rectifier 8V1 in the ALC/Attenuator Assembly 8A2, is a part of the automatic level control system. The purpose of the ALC system is to maintain a substantially constant rf oscillator output level for a given setting of the ATTENUATION dial over the entire oscillator frequency range of 925 to 1225 megahertz. A functional view of ALC/Attenuator Assembly 8A2 is shown in figure 4-38.

Rf oscillator output is picked up electrostatically and fed through a section of RG-55/U coaxial cable to a metal disc in the ALC rectifier housing where it connects to the plate of the type 2B22 ALC rectifier 8V1. Rectified output is fed through low pass filter 8Z2 to be used in the Calibration-Control unit. (See figure 4-29 for schematic diagram of the automatic level control amplifier in the Calibration-Control unit.)

3. ATTENUATOR. - The attenuator waveguide in the ALC/Attenuator Assembly 8A2 controls the level of the rf signal appearing at SG OUT connector 8J6. The rf oscillator output is fed to the metal disc which connects to the plate cap of ALC rectifier 8V1. This metal disc and tube 8V1 are concentric within a cylindrical waveguide in which a piston is driven by a lead screw mechanically geared to the ATTENUATION indicator dial and controlled by the ATTENUATION knob. The metal disc functions as an rf radiator in the waveguide. An rf pickup probe is located at the end of the piston in the waveguide. The pickup probe is terminated by 47 ohm resistor 8R2.

The waveguide, which contains the piston and pickup probe, is of such dimensions as to operate below the cutoff frequency of the rf signal; hence, it attenuates the signal by an amount depending upon the distance between the metal disc and the probe on the piston. Variable attenuation is provided by moving the piston in or out. The pickup probe is connected to SG OUT coaxial connector 8J6 through a length of RG-55/U cable. The level of rf signal output can be varied from -21 to -121 db below one volt (feeding into a 53.5 ohm load), and can be read on the ATTENUATION dial on the front panel.

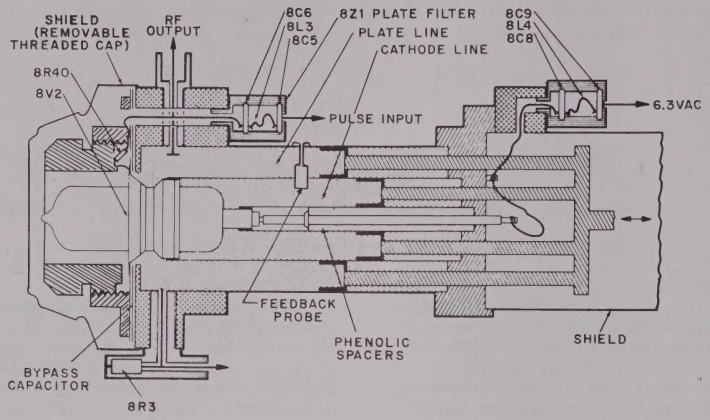


Figure 4-37. RF Oscillator Assembly 8A1, Cutaway Drawing

4. DEMODULATOR ASSEMBLY 8A4. - The demodulator converts pulsed rf signals to pulsed video signals. It consists of diode 8V3 and associated circuitry. The demodulator operates over the frequency range from 925 to 1225 megahertz, producing a signal which is useful for checking waveshapes and making power measurements. A functional view of the demodulator is given in figure 4-39.

Either externally or internally generated rf signals can be demodulated. For an externally generated rf signal, the demodulator input is fed through either LP IN connector 8J14 if the power level 0.5 to 35 peak watts, or through HP IN connector 8J15 if the power level is 35 to 3500 peak watts. A small portion of the externally generated signal is applied to the input of the wavemeter

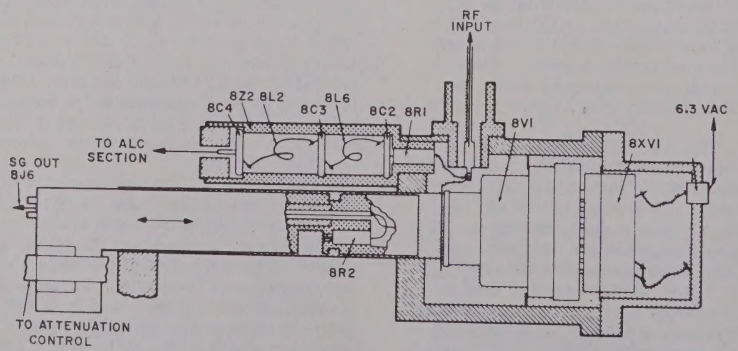


Figure 4-38. ALC/Attenuator Assembly 8A2, Cutaway Drawing

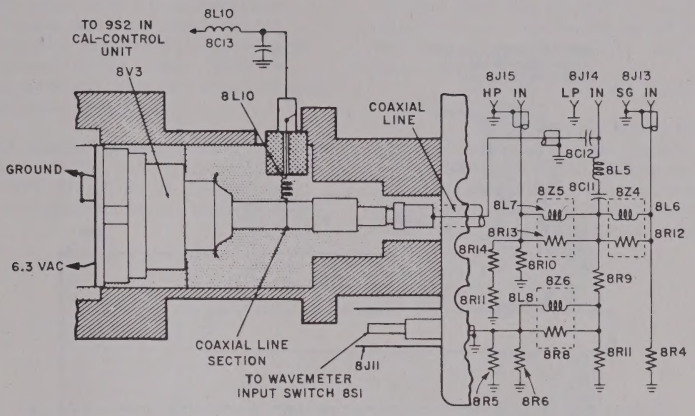


Figure 4-39. Demodulator Assembly 8A4, Functional Drawing

through 8J11 so that frequency measurements can be made. Attenuation between 8J15 and 8V3 is provided by the attenuation network shown in the overall schematic diagram of figure 5-64.

When the internally generated rf signal from Coder Simulator SM-197A/UPM-98 is to be demodulated, the modulated rf signal is fed into the demodulator through SG IN connector 8J13. An attenuated output from the rf signal generator is available at 8J14 and 8J15 for this purpose. Approximately 13 db of attenuation between 8J13 and 8J14 is provided by the attenuation network. Attenuation of approximately 37 db between 8J13 and 8J15 is provided by the same attenuation network.

For either externally or internally generated rf signals, the rf energy is coupled through 8C12 and transmission line 8TL1 to the plate of 8V3 (2B22 lighthouse-type diode). The resulting negative pulses are fed on through rf chokes 8L9 and 8L10. The demodulator output then goes through 8J18 to VIDEO OUT switch 9S2 in the Calibration-Control unit.

In order to provide the correct termination impedance, the dummy load 8P15 (attached) must be inserted into the HP IN connector when LP IN is connected to external equipment; similarly, 8P15 must be inserted into the LP IN connector when HP IN is connected to external equipment.

5. WAVEMETER ASSEMBLY 8A3. - The wavemeter, which is of the tuned cavity type, is used for accurate measurement of rf signal frequencies in the range from 925 to 1225 megahertz. It may be used to measure the frequency of the signal produced by internal rf oscillator 8V2 or of signals from external sources. To measure the frequency of the 8V2 output, WAVEMETER INPUT switch 8S1 is placed in the SIG GEN (signal generator) position. To measure the frequency of a signal from an external rf source, the signal is brought in through LP IN connector 8J14 or HP IN connector 8J15 and WAVEMETER INPUT switch 8S1 is placed in the DEMOD position. The wavemeter is tuned by means of the WAVEMETER FREQUENCY control to match its resonance characteristics to the incoming signal frequency. This condition is indicated by a needle dip in the Calibration-Control front panel meter. The wavemeter accuracy is ± 0.7 megahertz when used in conjunction with the calibration charts furnished with the equipment. A drawing showing the construction of the wavemeter assembly is given in figure 4-40.

The wavemeter consists of a cavity with a mechanically driven tuning rod. Rf energy is coupled into the coaxial line section by inductive loop 8L13. Tuning is accomplished by shortening or increasing the length of the tuning rod in the cavity to obtain a quarter-wave spacing with respect to the end cap. This is done by means of a screw-driven plunger which is connected through a gear train to a digital indicator-type dial (and knob) labeled WAVEMETER FREQUENCY on the front panel. Invar alloy, which has a very low thermal coefficient of expansion, is used in the construction of the center conductor and in the rear housing structure of the line section to keep resonance frequency shift with temperature change at a low value. The main outer conductor is made of brass, since changes in its dimensions will cause no significant change in frequency. When the tuning rod is adjusted to give a spacing which is one-quarter wavelength of the input signal, rf energy is transferred to the output pickup loop 8L12. This rf signal is rectified by diode 8CR1 so that the output of the wavemeter consists of negative pulses. These negative pulses are applied through connectors 8J12, 8J20, and 8J23 to 9P1 in the Calibration-Control unit where they are amplified, integrated by the wavemeter integrator, and their amplitude measured by a meter.

(e) ELAPSED TIME METER CIRCUIT DESCRIPTION. - The elapsed time meter, mounted on the Coder Simulator SM-197A/UPM-98

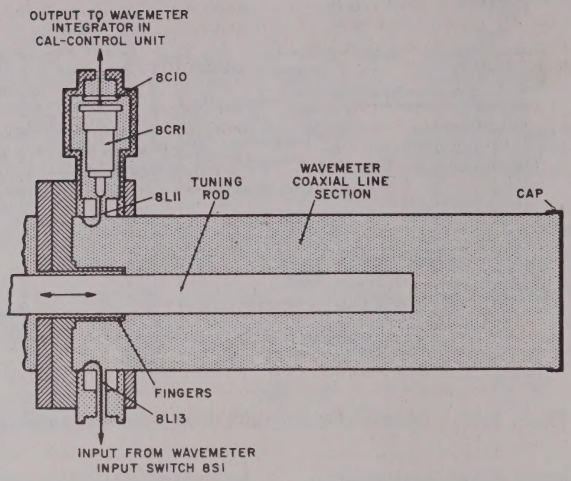


Figure 4-40. Wavemeter Assembly 8A3, Cutaway Drawing

front panel, is of a type which is independent of input power frequency, since it is powered by dc. A special dc supply is included in the Equipment Case for this purpose. (See schematic diagrams of SM-197A/UPM-98 chassis, figure 5-64 and Equipment Case CY-2796A/UPM-98, figure 5-57.) The power supply consists of transformer 7A1T1, a rectifier bridge made up of diodes 7A1CR1 through 7A1CR4, and a filter made up of resistor 7A1R1 and capacitor 7A1C1. Regulation at 27 volts is provided by breakdown diode 7A1VR1.

4-5. FUNCTIONAL SECTION DESCRIPTION, RADAR TEST SET TS-1253A/UP.

a. OVERALL RADAR TEST SET TS-1253A/UP DESCRIPTION. - Radar Test Set TS-1253A/UP is made up of a panel-chassis assembly in the form of a drawer containing power supply circuits and four plug-in units (see block diagram in figure 4-41):

(1) Display Unit,
(2) Sweep and Intensity Mark Unit,
(3) Crystal Mark and Sync Unit,
(4) SIF Coder

The pulse generator circuits of the Crystal Mark and Sync unit operate from externally generated trigger pulses (either positive or negative) or from internally-generated trigger pulses. Positive suppressor, zero delay (0), and delayed trigger output signals are supplied at panel connectors.

The delayed trigger pulse is also provided at the input power connector of the unit for triggering the Interrogation Coder in the SM-197A unit, and for use within the TS-1253A unit. Internal connections supply output triggers from this unit to the Sweep and Intensity Mark unit. Internal connections also supply video marker output from the Crystal Mark and Sync unit to the Display unit, providing an accurate time calibration on the display sweep.

The Sweep and Intensity Mark unit contains a triggered sweep generator and an intensity marker generator. Horizontal sweep output is supplied to the cathode ray tube of the Display unit. Intensity marker output is also supplied to the cathode ray tube to provide time-scale markers for the different sweep durations. Appropriate trigger inputs are selected by operator controls. All connections to the Sweep and Intensity Mark unit are internal.

The Display unit contains a cathode-ray tube, an rf-type high voltage supply, and an amplifier for the input video signal. Video markers, intensity markers, horizontal sweep voltage, and power are supplied from the other units of the test set for operation of the Display unit. A panel connector is provided for video input.

The SIF Coder requires an external positive trigger to initiate the generation of a pulse train. Operator controls permit code number selection and output amplitude adjustment. Continuously variable low level output is supplied at the VARI OUTPUT panel connector. High level output is supplied at the

MOD DRIVE panel connector. A two-position switch controls the relative output levels from both panel connectors. The Crystal Mark and Sync unit, or other external equipment, supplies the input trigger to the panel connector of the SIF Coder. With the exception of the power supply, this unit is a complete, self-contained pulse train generator.

The TS-1253A panel-chassis assembly contains the power, control, rectifier, and regulator circuits for Radar Test Set TS-1253A/UP. It also provides mountings and interconnections for the modular units of the test set.

b. RADAR TEST SET TS-1253A/UP TEST DATA.- Test data for Radar Test Set TS-1253A/UP is given in the data for the individual functional sections. This data includes waveforms and voltage and resistance readings.

c. RADAR TEST SET TS-1253A/UP CIRCUIT DESCRIPTION.

(1) CRYSTAL MARK AND SYNC UNIT.- The circuit functions of the Crystal Mark and Sync unit are shown in the block diagram figure 4-42 and are described below. Waveforms for this unit are shown in figure 4-43 and voltage and resistance readings are given in tables 4-7 and 4-8.

TABLE 4-7. CRYSTAL MARK AND SYNC UNIT VOLTAGE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
3V1	0.54	0	FIL	FIL	+235	+110	0		
3V2	+250	-27	+0.04	FIL	FIL	0	-18.5	FIL	+250
3V3	+240	0	+6.2	FIL	FIL	+240	0	+5.6	FIL
3V4	+200	-44	0	FIL	FIL	+70	+3.3	+3.3	FIL
3V5	+250	-15	+4.3	FIL	FIL	+250	-35	+0.03	FIL
3V6	FIL	+0.1	-16.5	+250	0	+250	-16	0	FIL
3V7	+250	40	0	FIL	FIL	-50	-49	FIL	-40
3V8	+12.3	-34	0	FIL	FIL	+220	+0.3	+3.2	FIL
3V9	+195	+12.3	+14.5	FIL	FIL	+145	+48	+14.5	FIL
3V10	+220	0	+3	FIL	FIL	+7.7	+.77 to -34	0	FIL
3V11	FIL	0 to 3.2	+14.4 to -16	+220	0	+220	-14.6	0 to 0.34	FIL
3V12	+160 to +210	+46.5	+47	FIL	FIL	+190	+7.8 to +9.2	+47	FIL

Notes - (1) Voltage measurements taken with unit removed from chassis, but connected with a 24-connector service cable.

(2) SYNC SELECT switch in EXT (+) Position

(3) Electronic Multimeter used for voltage measurements

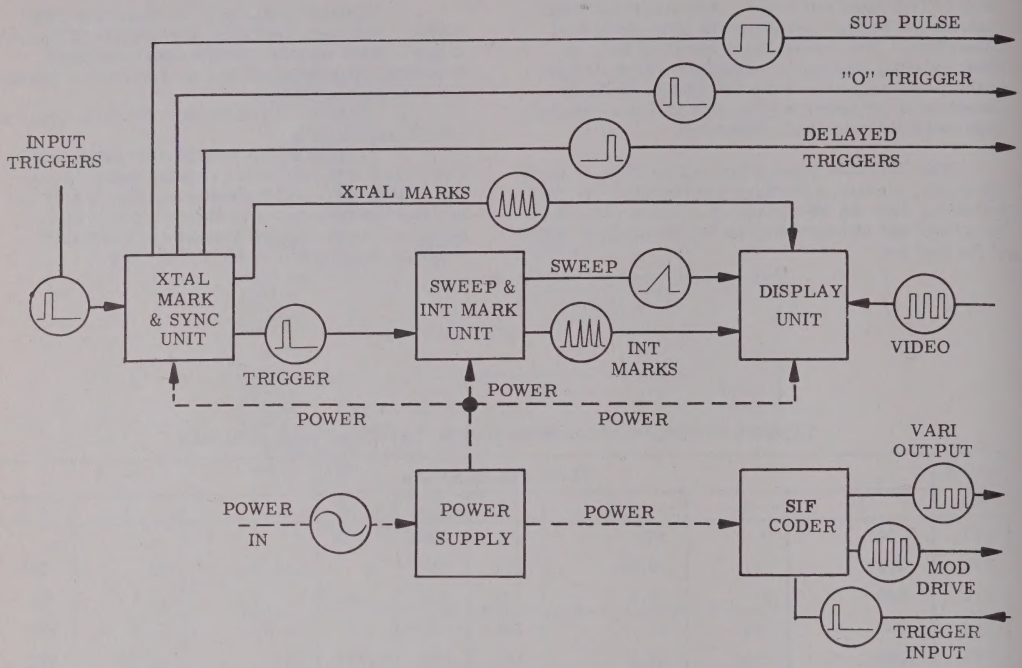


Figure 4-41. Radar Test Set TS-1253A/UP, Block Diagram

TABLE 4-8. CRYSTAL MARK AND SYNC UNIT RESISTANCE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
3V1	47K	0	∞	∞	33K	80K	0	---	---
3V2	35K	3.7K	480	∞	∞	0	2.7K	∞	35K
3V3	110K	4.7K	10K	∞	∞	35K	1.3 Meg	4.8K	∞
3V4	45K	52K	500	∞	∞	45K	450	390	∞
3V5	45K	15K	270	∞	∞	35K	4.5 Meg	85	∞
3V6	∞	180	47K	35K	0	35K	4.5 Meg	470	∞
3V7	35K	90K	470	∞	∞	2.8K	400K	∞	90K
3V8	220K	550K	0	∞	∞	35K	1K Δ	750	∞
3V9	40K	220K	3.6K	∞	∞	40K	32K	3.6V	∞
3V10	35K	100 Δ	750	∞	∞	220K	600K	0	∞
3V11	∞	470	6.8K	35K	0	35K	6.8K	470	∞
3V12	45K	30K	3.6K	∞	∞	40K	220K	3.6K	∞

Notes: 1. Resistance measurements taken to chassis ground with unit removed and disconnected.

2. Δ Indicates that diode in circuit will cause readings to vary.

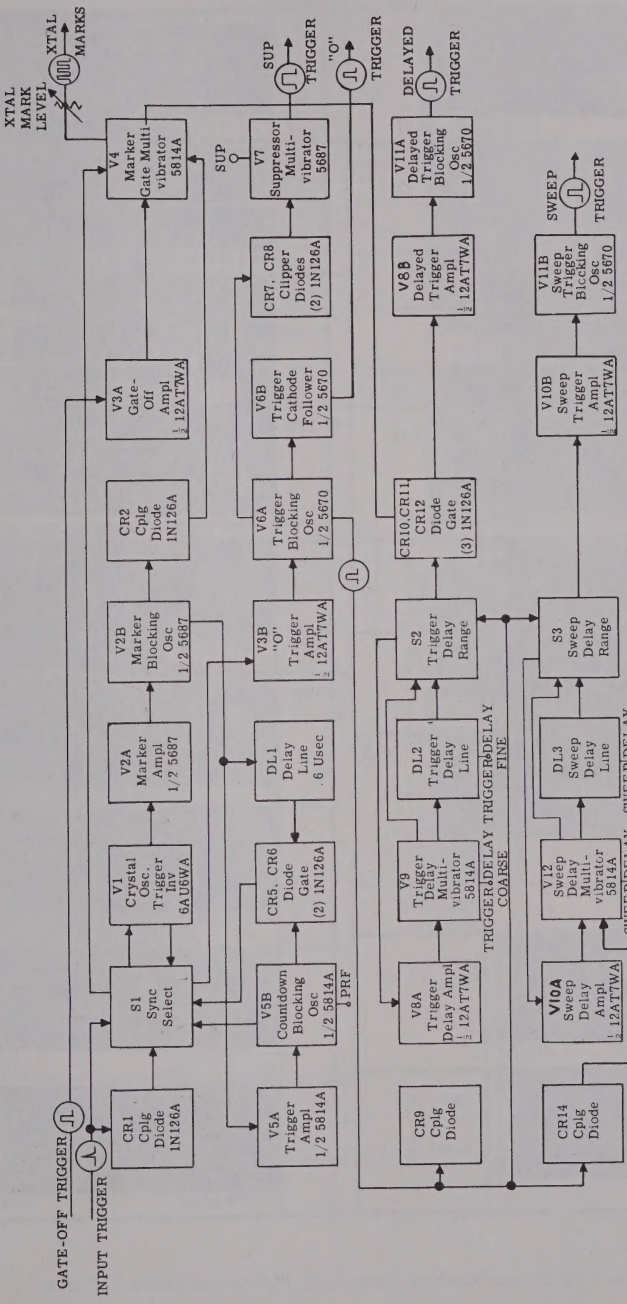


Figure 4-42. Crystal Mark and Sync Unit, Block Diagram

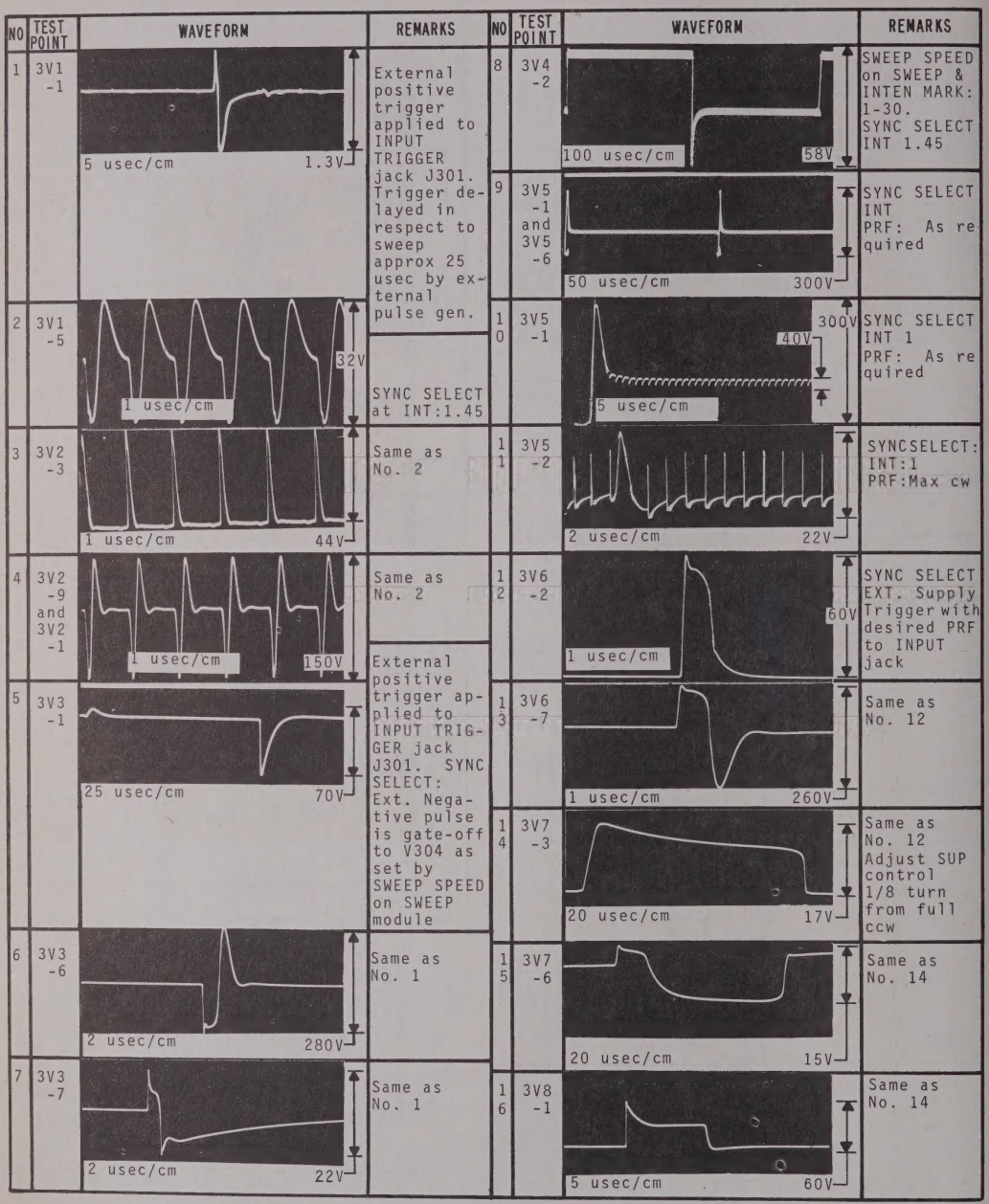


Figure 4-43 Crystal Mark and Sync Unit, Waveforms (Sheet 1 of 2)

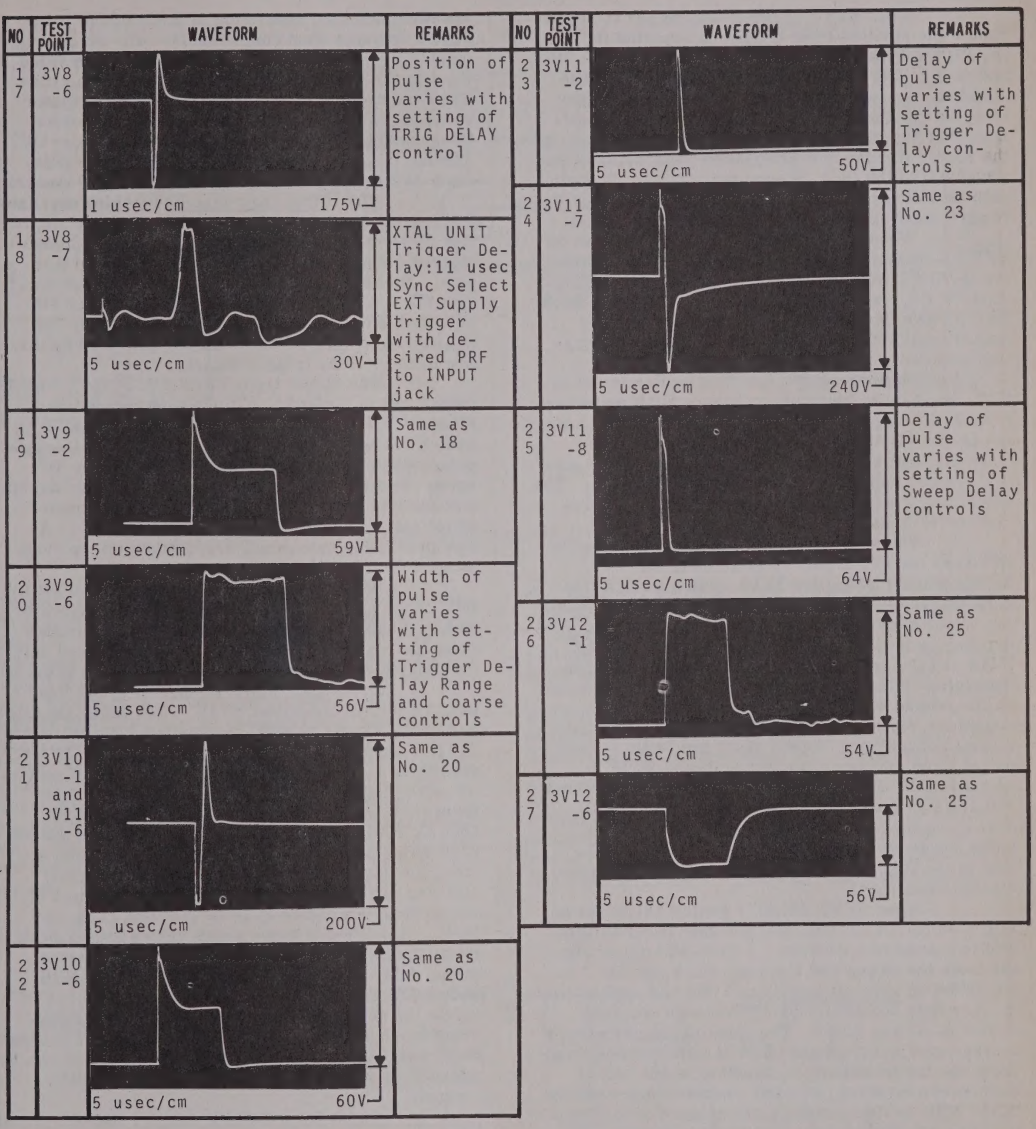


Figure 4-43. Crystal Mark and Sync Unit, Waveforms (Sheet 2 of 2)

When SYNC SELECT switch 3S1 is set to EXT + the positive input trigger is supplied through the INPUT TRIGGER connector, through switch 3S1, and to the input of 0 trigger amplifier 3V3B. The amplified trigger output from 3V3B drives trigger blocking oscillator 3V6A. Trigger blocking oscillator 3V6A generates 0 (zero-delay) triggers having the required pulse characteristics regardless of the waveform of the input trigger being used. Trigger cathode follower 3V6B provides a low impedance 0 trigger ouput for operation of external equipment.

When SYNC SELECT switch 3S1 is set to EXT -, the negative input trigger is supplied through the INPUT TRIGGERS connector, through coupling diode 3CR1, switch 3S1, trigger inverter 3V1, back through switch 3S1, and to the input of 0 trigger amplifier 3V3B. The rest of the 0 trigger generation process is as previously described.

When the SYNC SELECT switch is set to INT, count-down blocking oscillator 3V5B produces a positive trigger signal, the frequency of which is set by the PRF control. The output from count-down blocking oscillator 3V5B is applied to the input of 0 trigger amplifier 3V3B through switch 3S1. The remaining 0 trigger generation process is as previously described.

When SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00), crystal oscillator 3V1 drives marker amplifier 3V2A, which in turn triggers marker blocking oscillator 3V2B. The resulting output is crystal-controlled marker pulses. The marker pulses are amplified by trigger amplfier 3V5A and then used to trigger count-down blocking oscillator 3V5B. The countdown ratio is determined by the setting of the PRF control. The output from countdown blocking oscillator 3V5B controls a gate circuit consisting of diodes 3CR5 and 3CR6. The output from marker blocking oscillator 3V2B is applied to the diode gate circuit through delay line 3DL1. The first marker pulse passed on to 3S1 during the gate-on interval functions as a trigger pulse for generation of the 0 trigger output. The rest of the 0 trigger generation process is as previously described.

When SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00), marker gate multivibrator 3V4 is placed in operation. A gate-off trigger signal from the Sweep and Intensity Mark unit is amplified by gate-off amplifier 3V3A and applied to marker gate multivibrator 3V4 through coupling diodes 3CR3 and 3CR4. The gate-off trigger causes marker gate multivibrator 3V4 to switch conduction from one triode section to the other at the end of each sweep interval. Marker input through coupling diode 3CR2 is then passed on by marker gate multivibrator 3V4 during every other sweep cycle. The amplitude of the crystal marker output signal passed on to the Display unit video amplifier circuits is set by the XTAL MARK LEVEL control. Gate pulse output from marker gate multivibrator 3V4 opens a diode gate circuit consisting of diodes 3CR11 and 3CR12. This provides delay trigger output for equipment under test and provides video input to the Display unit during the alternate sweep cycles.

When SYNC SELECT switch 3S1 is set to INT, EXT +, or EXT - marker gate multivibrator 3V4 is disabled. There is no crystal marker output, but the diode gate consisting of diodes 3CR11 and 3CR12 remains open continuously. The delay trigger output to equipment under test thus provides video input to the Display unit during every sweep cycle. The output signal from trigger blocking oscillator 3V6A is clipped by diodes 3CR7 and 3CR8 before being used to trigger suppressor multivibrator 3V7. The duration of the positive SUP TRIGGERS pulse from 3V7 is adjustable by means of the SUP control.

The output from trigger blocking oscillator 3V6A is coupled to the input of trigger delay amplifier 3V8A through capacitor 3C31. The amplified trigger output drives trigger delay multivibrator 3V9. The multivibrator output drives trigger delay line 3DL2. TRIGGER DELAY RANGE switch 3S2 selects the circuit and pulse source to obtain the desired time delay. Zero delay is provided by direct use of the 0 delay trigger signal.

The output from TRIGGER DELAY RANGE switch 3S2 is applied to a diode gate consisting of diodes 3CR11 and 3CR12. When SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00) the gate pulse output from marker gate multivibrator 3V4 opens the diode gate circuit during alternate Display unit sweep cycles. This triggers the equipment under test during the alternate sweep cycles. As was previously explained, every other sweep cycle is used for crystal marker display.

When SYNC SELECT switch 3S1 is set to INT, EXT +, or EXT -, marker gate multivibrator 3V4 is disabled and the diode gate circuit remains open continuously. Display unit sweep is used only for video display, no crystal markers being present.

Diode gate output is applied to the input of delayed trigger amplifier 3V8B. The amplified trigger output drives delayed trigger blocking oscillator 3V11A. Delayed trigger blocking oscillator 3V11A generates a delayed trigger output having the required pulse characteristics regardless of input waveform changes for different settings of TRIGGER DELAY RANGE switch 3S2. Delayed trigger output is supplied to the equipment under test through a front panel connector. The output from trigger blocking oscillator 3V6A is coupled to the input of sweep delay amplifier 3V10 by coupling capacitor 3C41. Amplified trigger output drives sweep delay multivibrator 3V12. Multivibrator output drives sweep delay line 3DL3. SWEEP DELAY RANGE switch 3S3 selects the circuits and pulse source to obtain the desired time delay. Zero delay is provided by direct use of the 0 delay trigger. The short delay range uses sweep delay line 3DL3 which can be adjusted by means of the SWEEP DELAY FINE control.

Output from SWEEP DELAY RANGE switch 3S3 is applied to the input of sweep trigger amplifier 3V10B. Amplified trigger output drives sweep trigger blocking oscillator 3V11B. Sweep trigger blocking oscillator 3V11B generates a sweep trigger output having the required pulse characteristics regardless of input waveform changes for different settings of SWEEP DELAY RANGE switch 3S3. Sweep trigger output is supplied to the Sweep and Intensity Mark unit through internal connections.

(a) 0 TRIGGER GENERATOR CIRCUIT.- When SYNC SELECT switch 3S1 is set to EXT +, as shown in figure 4-44, the positive input

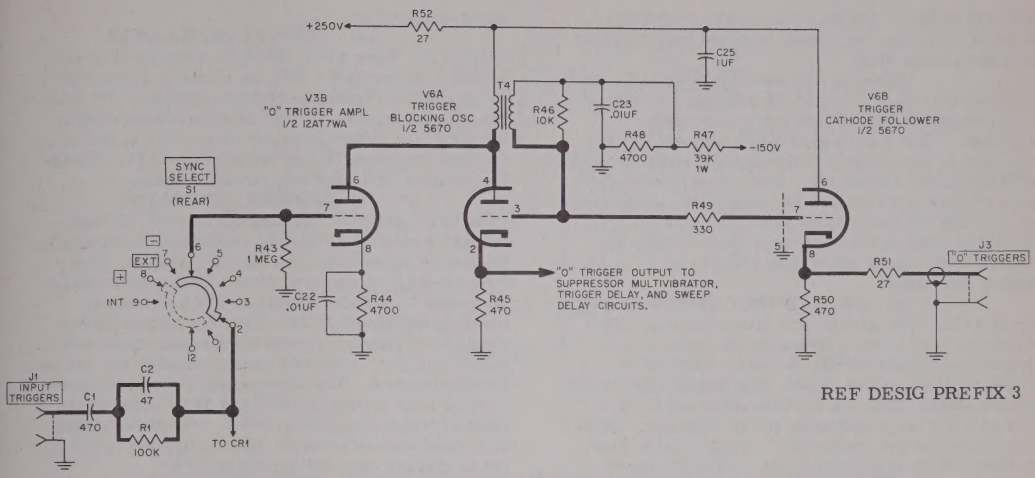


Figure 4-44. "O" Trigger Generator, Simplified Schematic Diagram

trigger from INPUT TRIGGERS connector 3J1 is differentiated by a network consisting of capacitor 3C1, capacitor 3C2, resistor 3R1, and the input-circuit impedance of 0 trigger amplifier 3V3B. This differentiator action provides proper equipment synchronization with various input trigger pulse durations. A common plate load circuit couples the output from 0 trigger amplifier 3V3B to trigger blocking oscillator 3V6A. Single-shot operation provides a regenerated output trigger for each input trigger. This output trigger has the required pulse characteristics regardless of the waveform of the input trigger being used. The 0 trigger output developed across cathode load resistor 3R45 is used by the circuits within the test set. The 0 trigger voltage at grid pin 3 of trigger blocking oscillator 3V6A is used to drive trigger cathode follower 3V6B. Low impedance output at 0 TRIGGERS connector 3J3 is used for operation of external equipment. Output loading at this point does not affect the internal functions of the test set.

(b) TRIGGER INVERTER CIRCUIT.- When SYNC SELECT switch 3S1 is set to EXT -, as shown in figure 4-45, the negative input trigger from INPUT TRIGGERS connector 3J1 is differentiated by a network consisting of capacitor 3C1, capacitor 3C2, resistor 3R1, and the input circuit impedance of trigger inverter 3V1. This differentiator action provides proper equipment synchronization with various input trigger pulse durations. While positive input triggers are properly routed through the

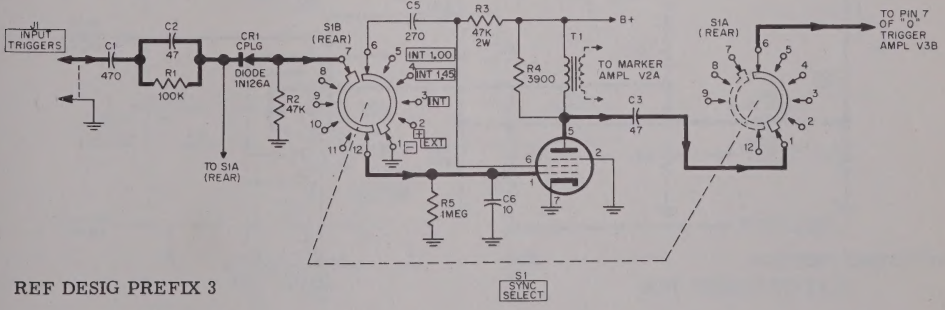


Figure 4-45. Trigger Inverter, Simplified Schematic Diagram.

contacts of SYNC SELECT switch 3S1, coupling diode 3CR1 is used to convey negative input triggers to grid resistor 3R5.

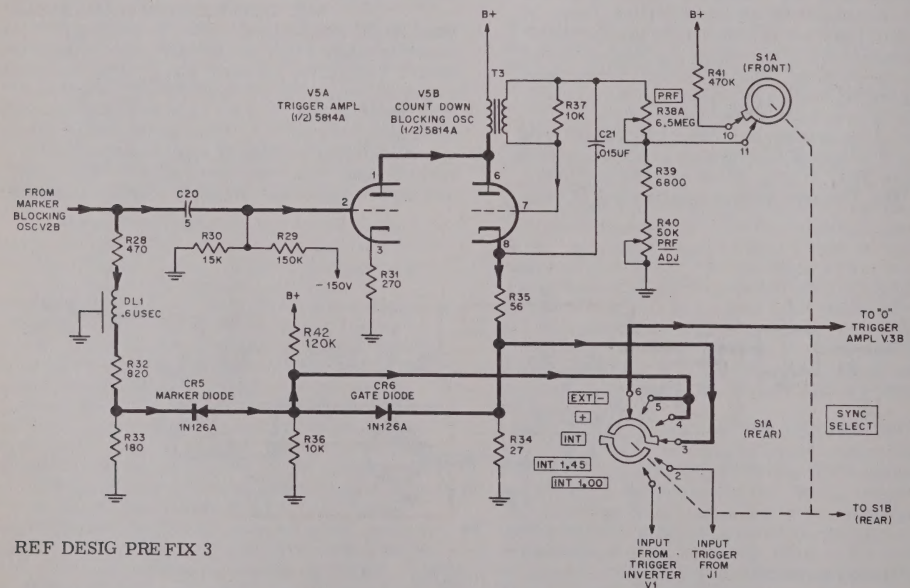
Resistor 3R3 and capacitor 3C6, used for oscillator operation of tube 3V1, have no significant circuit function in this particular mode of operation. The screen grid (pin 6) of tube 3V1 is bypassed by capacitor 3C5 through the contacts of SYNC SELECT switch 3S1. Positive trigger output from trigger inverter 3V1 is coupled through capacitor 3C3 and the contacts of SYNC SELECT switch 3S1 to the input of 0 trigger amplifier 3V3B. The remaining 0 trigger generation process is as previously described.

(c) PRF CONTROL CIRCUIT.- See figure 4-46. The grid circuit time-constant determines the free running frequency of countdown blocking oscillator 3V5B. It can be adjusted by means of PRF control 3R38A. Prf Range Adjustment potentiometer 3R40 is a service adjustment. It is normally set for a maximum prf of 4100 pps. Positive trigger output, developed across cathode load resistor 3R34, is applied to the grid of 0 trigger amplifier 3V3B through the contacts of SYNC SELECT switch 3S1. The remaining 0 trigger generation process is as previously described. Marker diode 3CR5, gate diode 3CR6, and trigger amplifier 3V5A are inoperative for this particular mode of operation.

(d) CRYSTAL OSCILLATOR CIRCUIT.- When SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00), as shown in figure 4-47, the screen of crystal controlled oscillator 3V1 functions as the anode of a tube in a Pierce oscillator circuit. The output from oscillator 3V1 is fed to marker amplifier 3V2 by transformer 3T1. Damping resistor 3R4 prevents circuit ringing.

(e) MARKER GENERATOR CIRCUIT.- Output from transformer 3T1 drives marker amplifier 3V2A into conduction to initiate production of an amplified marker trigger. (See figure 4-48.) A common plate load circuit couples the output of marker amplifier 3V2A to marker blocking oscillator 3V2B. The blocking oscillator single-shot operation provides a regenerated output pulse having the required characteristics for use as a video marker. The pulse output developed across cathode load resistors 3R12 and 3R13 is fed to the input of trigger amplifier 3V5A. The pulse output developed across resistor 3R13 is applied to the input of marker gate multivibrator 3V4.

(f) MARKER GATE CIRCUIT.- When SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00), as shown in figure 4-49, the switch contacts across pins 7 and 8 (grid and cathode) of marker gate multivibrator 3V4 are open and the



REF DESIG PREFIX 3

Figure 4-46. PRF Control Circuit, Simplified Schematic Diagram

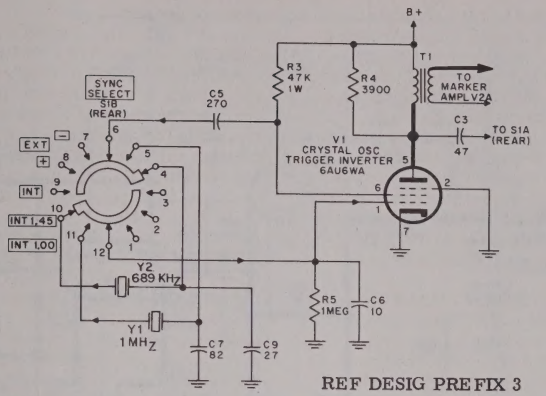


Figure 4-47. Crystal Controlled Oscillator Circuit, Simplified Schematic Diagram

marker gate circuit is in operation. A positive gate-off pulse is supplied by the Sweep and Intensity Mark unit at the end of each sweep interval. This pulse is applied to the grid of gate-off amplifier 3V3A. The output of gate-off amplifier 3V3A is coupled to the grids of marker gate multivibrator 3V4 by means of capacitors 3C59 and 3C60. The negative gate-off pulse causes the conducting section of the tube to cut off, which in turn drives the other section into conduction. Since marker gate multivibrator 3V4 is a bistable circuit, each gate-off pulse will switch conduction from one tube section to the other.

Output from marker blocking oscillator 3V2B is coupled to grid pin 2 of marker gate multivibrator 3V4 by means of capacitor 3C13, coupling diode 3CR2, and resistor 3R18. Cathode-follower marker output is developed across XTAL MARK LEVEL control 3R64 during conduction of this tube section. This adjustable marker output is supplied to the Display unit.

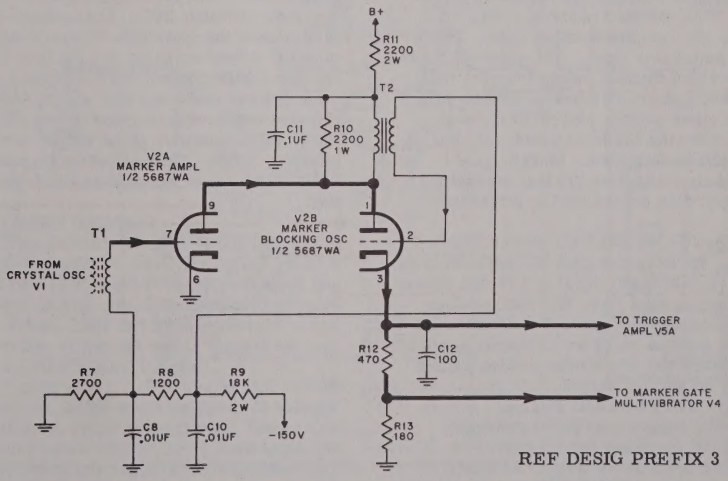


Figure 4-48. Marker Generator Circuit, Simplified Schematic Diagram

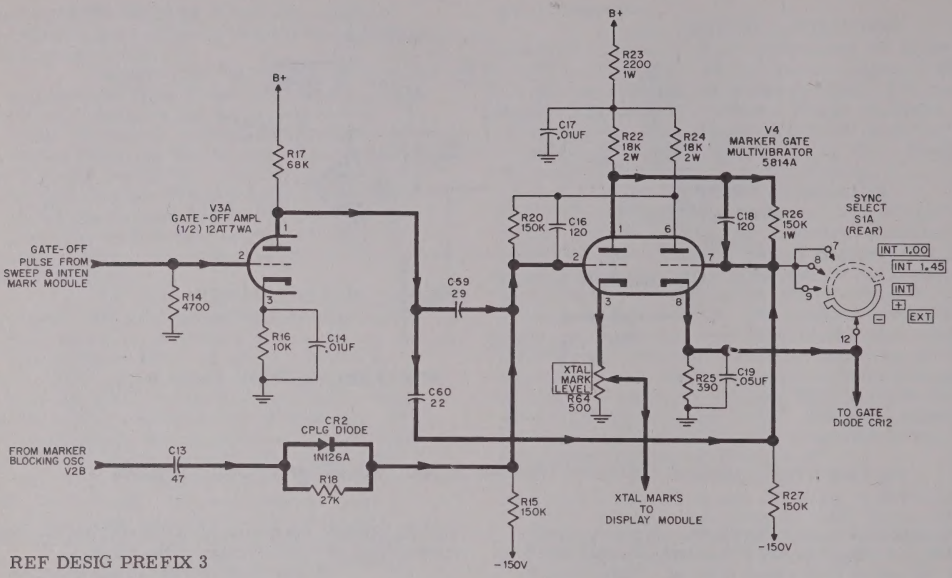


Figure 4-49. Marker Gate Circuit, Simplified Schematic Diagram

The gate-off pulse at the end of the sweep interval causes marker gate multivibrator 3V4 to switch conduction to the other section. A positive gate output developed across load resistor 3R25 is applied to gate diode 3CR12 in the delayed-trigger circuit. This makes available a delayed trigger signal for the equipment under test. There is no marker output at this time. The gate-off pulse at the end of this video display sweep interval will again cause marker gate multivibrator 3V4 to switch conduction to the other section and markers will again be displayed during the sweep interval, but no delayed trigger will be supplied. Marker gate multivibrator 3V4 thus supplies crystal markers and delayed trigger gate pulses during alternate sweep intervals.

When SYNC SELECT switch 3S1 is set to EXT -, EXT +, or INT, the grid and cathode (pins 7 and 8) of marker gate multivibrator 3V4 are shorted together, removing bias from this tube section and causing it to conduct continuously. Continuous conduction of this section gives a continuous positive "gate" output. Since the other tube section cannot conduct, there is no marker output.

(g) SUPPRESSOR PULSE GENERATOR. - The suppressor pulse generator shown in figure 4-50 functions for all modes of operation. The 0 trigger from trigger blocking oscillator 3V6A is coupled into the circuit by capacitor 3C24. The negative undershoot is removed by clipper diode 3CR7. Diode bias supplied by divider resistors 3R55 and 3R56 determines the positive clipping level. Capacitor 3C27 couples the clipped pulse to cathode (pin 6) of suppressor multivibrator 3V7. The positive 250-volt and negative 150-volt supplies together provide an effective 400-volt plate supply solely for the input triode section of suppressor multivibrator 3V7. This supply arrangement also makes the plate (pin 9) operating voltage suitable for direct coupling to grid (pin 2) of the output section. SUP control 3R38B adjusts the time constant for the desired pulse width between 2 and 220 microseconds. Conduction of the output section develops suppressor pulse output across cathode load resistor 3R63. This output is supplied to SUP TRIGGERS connector 3J2 on the front panel of the unit.

(h) TRIGGER DELAY CIRCUIT. - When TRIGGER DELAY RANGE switch 3S2 is set to 0 (zero delay) as shown in figure 4-51, 0 trigger input from divider resistors 3R81 and 3R82 (from trigger blocking oscillator 3V6A) is fed on to clipper diode 3CR10 through the 3S2B switch contacts 1 and 5 and the trigger delay circuit is not in use.

When TRIGGER DELAY RANGE switch 3S2 is set to 1-11, the zero trigger input is applied to coupling diode 3CR9 and the positive trigger output from trigger delay amplifier 3V8A drives the input section of trigger delay multivibrator 3V9 into conduction. Trigger delay multivibrator 3V9 functions as a single-shot multivibrator. Damping resistor 3R76 and delay line 3DL2 make up the plate load of the output section. Resistors 3R79 and inductor 3L2 make up the delay line termination.

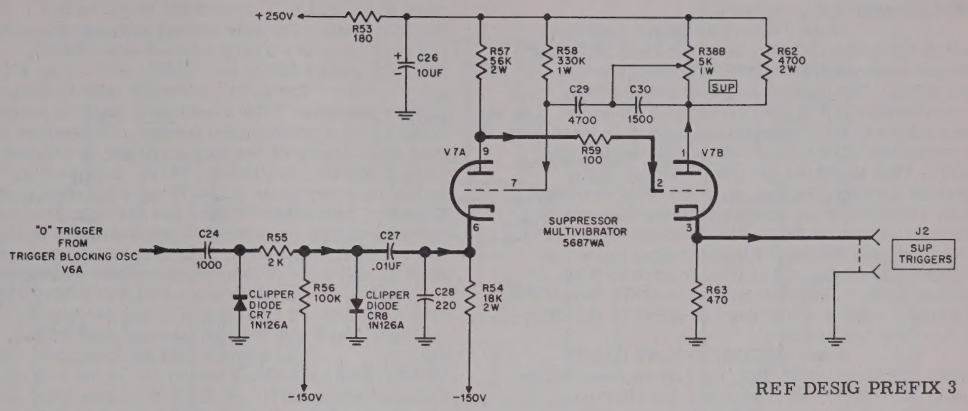


Figure 4-50. Suppressor Pulse Generator, Simplified Schematic Diagram

The TRIGGER DELAY FINE control varies the position of pickup coil 3L3 on the delay line, thus determining the amount of time delay to be added to that provided by the multivibrator. The trailing edge of the multivibrator output pulse is differentiated, producing in a positive delay line output pulse that triggers the circuits which follow. In this switch position, the output of the first section of 3V9 is coupled directly to the second section, by-passing the TRIGGER DELAY COARSE control. For this reason, TRIGGER DELAY COARSE control 3R72 has no effect on operation when TRIGGER DELAY

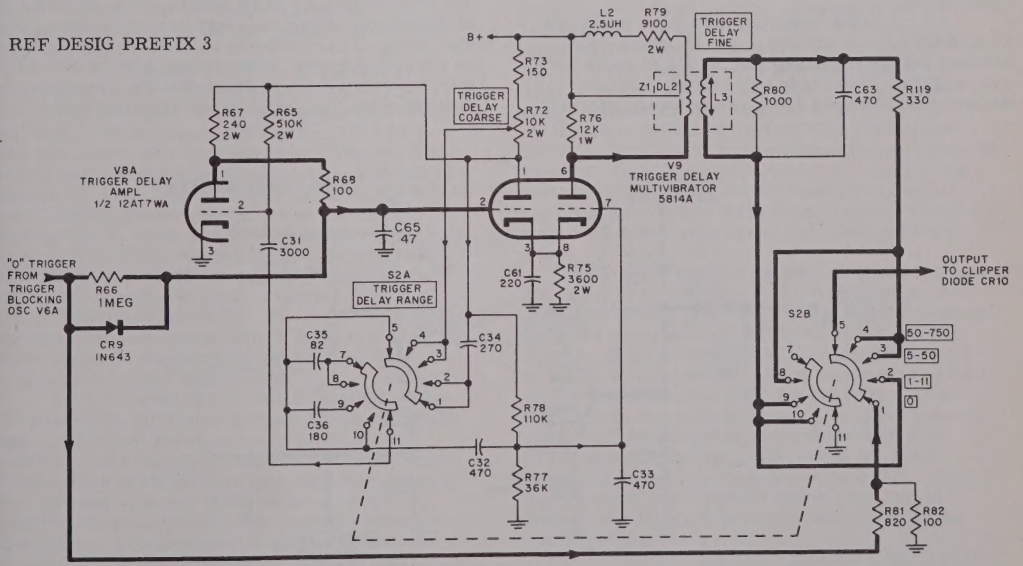


Figure 4-51. Trigger Delay Circuit, Simplified Schematic Diagram

RANGE switch 3S2 is set to 1-11.

When TRIGGER DELAY RANGE switch 3S2 is set to 5-50, coupling diode 3CR9 and trigger delay amplifier 3V8A function as previously described. The basic function of trigger delay multivibrator 3V9 is also unchanged. However, the capacitance in the multivibrator circuit is increased by switching 3C36 into the circuit, in series with 3C31. This lengthens the time constant of the coupling network, holding off conduction of trigger delay amplifier 3V8A and maintaining conduction of the input section of trigger delay multivibrator 3V9. This lengthens the multivibrator output pulse and increases the delay of the trigger derived from its trailing edge. TRIGGER DELAY RANGE switch 3S2 is in the circuit and will have an effect on the delay in this switch position.

When TRIGGER DELAY RANGE switch 3S2 is set to 50-750, the circuit functions as previously described. However, the effective capacitance of series-connected capacitors 3C31 and 3C36 is increased to the value of 3C31 (by shorting out capacitor 3C36) obtaining a still longer time constant.

(i) DELAY TRIGGER GENERATOR.- The pulse signal from the trigger delay circuit is applied to the junction of trigger diode 3CR11 and clipper diode 3CR10. Clipper diode 3CR10 clips off the negative pulses from the trigger delay circuit (see figure 4-52). Trigger diode 3CR11 and gate diode 3CR12 conduct because of bias current supplied through resistor 3R85. When no gate pulse is present, gate diode 3CR12 returns the trigger pulse to chassis ground through the low impedance cathode circuit of marker gate multivibrator 3V4 (see figure 4-49).

When a positive gate pulse is applied, diode 3CR12 stops conducting due to reverse bias, allowing the trigger pulse from 3CR11 to reach the grid of 3V8B. This diode gate circuit supplies delayed trigger pulses for alternate sweep intervals when SYNC SELECT switch 3S1 is set to INT 1.45 (or INT 1.00). The gate circuit supplies delayed triggers for every sweep interval when SYNC SELECT switch 3S1 is set to INT, EXT -, or EXT +.

The positive trigger input to delayed trigger amplifier 3V8B produces a negative output trigger in the conventional manner. A common plate load circuit couples the output trigger to delayed trigger blocking oscillator 3V11A. Single-shot operation provides an output trigger for each input trigger. This output trigger has the required pulse characteristics regardless of the waveform of the input trigger being used. The trigger signal developed across cathode load resistor 3R87 is supplied to external equipment through DELAYED TRIGGERS connector 3J4. It is supplied to the Sweep and Intensity Mark unit through internal connections.

(j) SWEEP DELAY CIRCUIT.- When SWEEP DELAY RANGE switch 3S3 is set to 0 (zero delay) as shown in figure 4-53, 0 trigger input from trigger blocking oscillator 3V6A is fed to divider resistors 3R109 and 3R110 from where it is passed through the switch contacts and on to sweep trigger amplifier V10B. The sweep delay circuit is not in use.

When SWEEP DELAY RANGE switch 3S3 is set to 1-11, the zero trigger input is applied to coupling diode 3CR14 and the positive trigger output from sweep delay amplifier 3V10A drives the input section of sweep delay multivibrator 3V12 into conduction. Sweep delay multivibrator 3V12 functions as a single-shot multivibrator. Damping resistor 3R104 and delay line 3DL3 make up the plate load of the output section. Resistor 3R107 and inductor 3L4 comprise the delay line termination. The SWEEP DELAY FINE control varies the position of pickup coil 3L5 on the delay line, thus determining the amount of time delay to be added to that provided by the multivibrator. The trailing edge of the multivibrator output pulse is differentiated, producing a positive delay line output pulse that triggers the

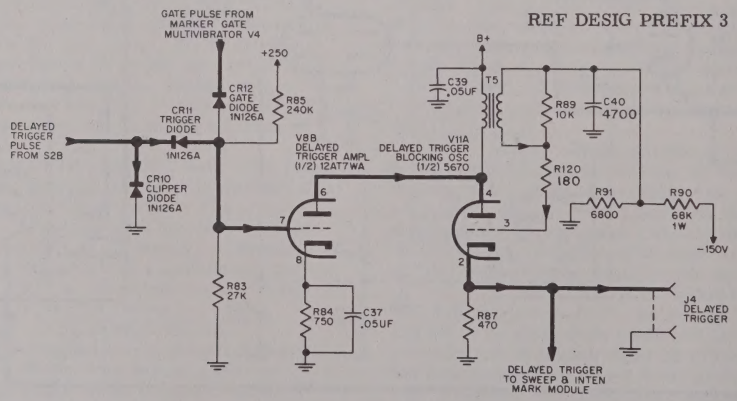


Figure 4-52. Delay Trigger Generator, Simplified Schematic Diagram

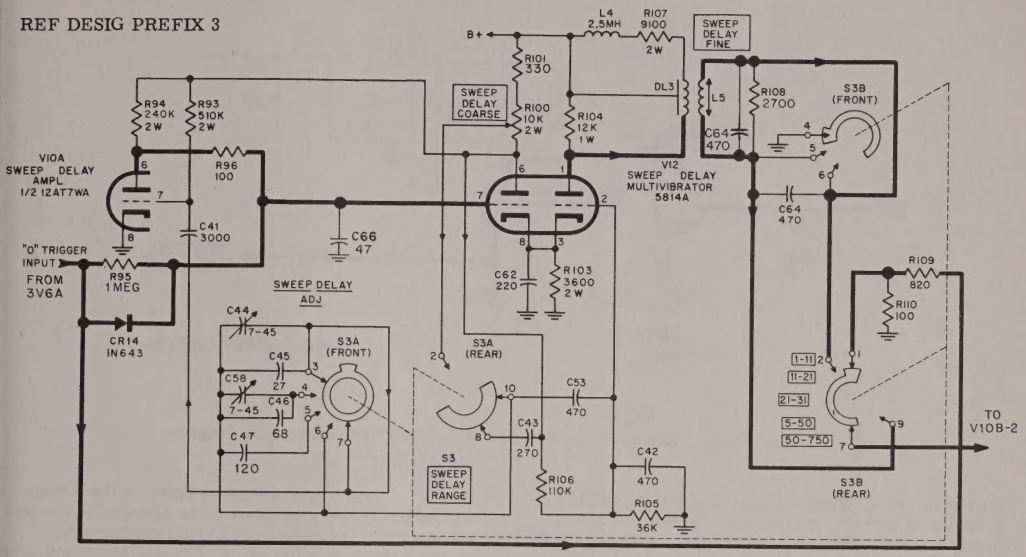


Figure 4-53. Sweep Delay Circuit, Simplified Schematic Diagram

circuits which follow. In this position of 3S3, the output of the first section of 3V12 is coupled directly to the second section, by-passing the SWEEP DELAY COARSE control. For this reason SWEEP DELAY COARSE control 3R100 has no effect on operation when SWEEP DELAY RANGE switch 3S3 is set to 1-11.

When SWEEP DELAY RANGE switch 3S3 is set to 11-21, coupling diode 3CR14 and sweep delay amplifier 3V10A function as previously described. Sweep delay multivibrator 3V12 functions as a single-shot multivibrator. The coupling network between plate pin 6 and grid pin 2 of multivibrator 3V10 consists of SWEEP DELAY COARSE control 3R100, resistor 3R101, resistor 3R105, resistor 3R106, capacitor 3C43, capacitor 3C53, and capacitor 3C42. Again SWEEP DELAY COARSE control 3R100 has no effect since its variable tap is connected to an open contact on SWEEP DELAY RANGE switch 3S3A. The multivibrator provides a ten-microsecond fixed delay since the output trigger is derived from the trailing edge of the ten-microsecond output pulse.

When SWEEP DELAY RANGE switch 3S3 is set to 21-31, coupling diode 3CR14 and sweep delay amplifier 3V10A function as previously described. The basic function of sweep delay multivibrator 3V12 is also unchanged. However, capacitors 3C46 and 3C58 are added in parallel with capacitors 3C44 and 3C45 to increase the effective capacitance. This lengthens the time constant of the coupling network, holding off conduction of sweep delay amplifier 3V10A and maintaining conduction of the input section of sweep delay multivibrator 3V12. This lengthens the multivibrator output pulse and increases the delay of the trigger derived from its trailing edge.

When SWEEP DELAY RANGE switch 3S3 is set to 5-50, coupling diode 3CR14 and sweep delay amplifier 3V10A function as previously described. The basic function of sweep delay multivibrator 3V12 is also unchanged. However, the delay multivibrator coupling network is modified by means of the contacts on switch 3S3. Capacitor 3C43 is switched out. Capacitor 3C53 and associated components are switched directly to the variable tap on SWEEP DELAY COARSE control 3R100. Capacitor 3C46 is switched out and replaced by capacitor 3C47 which has a larger capacitance value. This provides coarse sweep delay adjustment since the sweep delay output pulse is derived from the trailing edge of the multivibrator output pulse.

When SWEEP DELAY RANGE switch 3S3 is set to 50-750, the function of coupling diode 3CR14 and sweep delay multivibrator 3V12 remains the same as on the 5-50 SWEEP DELAY RANGE setting. However, the parallel capacitor network in series with capacitor 3C41 is shorted out to use the full capacitance of 3C41 for coupling. This lengthens the time constant of the coupling network, holding off conduction of sweep delay amplifier 3V10A and maintaining conduction of the input section of sweep delay multivibrator 3V12. This lengthens the multivibrator output pulse and increases the delay of the trigger derived from its trailing edge.

(k) SWEEP TRIGGER GENERATOR.- (See figure 4-54.) Positive trigger output from sweep delay multivibrator 3V12 is coupled through 3S3B to grid pin 2 of sweep trigger amplifier 3V10B. The resulting negative output trigger is

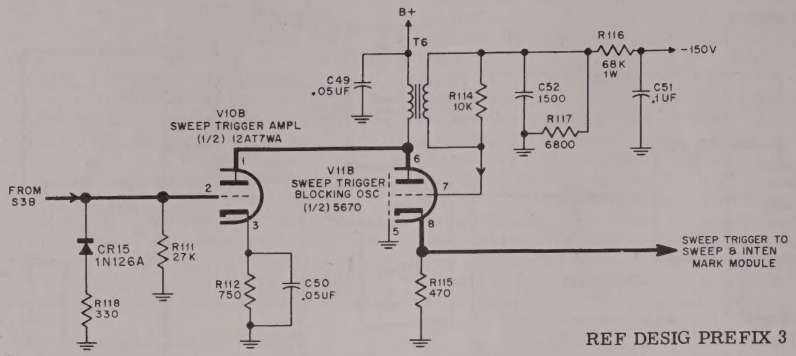


Figure 4-54. Sweep Trigger Generator, Simplified Schematic Diagram

coupled to sweep trigger blocking oscillator 3V11B by means of a common plate load circuit. Single-shot operation produces a regenerated output trigger for each input trigger. This output trigger has the required pulse characteristics regardless of the waveform of the input trigger being used. Sweep trigger output developed across cathode load resistor 3R115 is supplied to the Sweep and Intensity Mark unit through internal equipment connections.

(2) SWEEP AND INTENSITY MARK UNIT.- The circuit functions of the Sweep and Intensity Mark unit are shown in the block diagram (figure 4-55) and are described below. Waveforms for this unit are shown in figure 4-56. Voltage and resistance readings are given in tables 4-9 and 4-10.

All interconnections between the Sweep and Intensity Mark unit and other circuits of the test set are made by means of internal connectors. Sweep Trigger input from the Crystal Mark and Sync unit is normally supplied to the input of the sweep trigger amplifier 2V2A through the normally-closed contacts of DELAY STROBE SWEEP switch 2S4 and DELAY STROBE TRIGGER SWITCH 2S1. The trigger amplifier output is used to trigger sweep gate multivibrator 2V3. Clipper diode 2CR6 helps maintain the desired waveform. Output from sweep gate multivibrator 2V3 controls the conduction cycle of switch diode 2V5A. Output from sweep gate multivibrator 2V3 is fed back to neutralize the plate-cathode capacitance effects of switch diode 2V5A.

TABLE 4-9. SWEEP AND INTENSITY MARK UNIT VOLTAGE READINGS

Tube No.	Tube Pin Numbers								
	1	2	3	4	5	6	7	8	9
2V1	+86 to +227	0 to -28	-58	FIL	FIL	-50	-62	FIL	+168
2V2	+230	-10.4	0	FIL	FIL	+250	-47	-35	FIL
2V3	-62	-97	-97	FIL	FIL	-97	-110	FIL	0 to +0.6
2V4	+250	-62	-47	FIL	FIL	+250	-15 to -30	0 to +0.2	FIL
2V5	-48	+250	FIL	FIL	+250	0	-47	--	--
2V6	+102	-63	-58	FIL	FIL	-50	-62	FIL	+168
2V7	+242	+13	+20	FIL	FIL	+140	+10	+13	FIL
2V8	+170	0 to -5	+2.7	FIL	FIL	+92	0	+2.9	FIL
2V9	+250	-4.5	+190	FIL	FIL	+250	0	0	-35
2V10	+250	0	+120	FIL	FIL	+245	+1.75	0	-43
2V11	+250	-13 to -24	0.1 to +0.5	FIL	FIL	+250	-14	+0.05	FIL

Notes: 1. Voltage measurements taken with unit connected.
2. Electronic multimeter used for measurements.

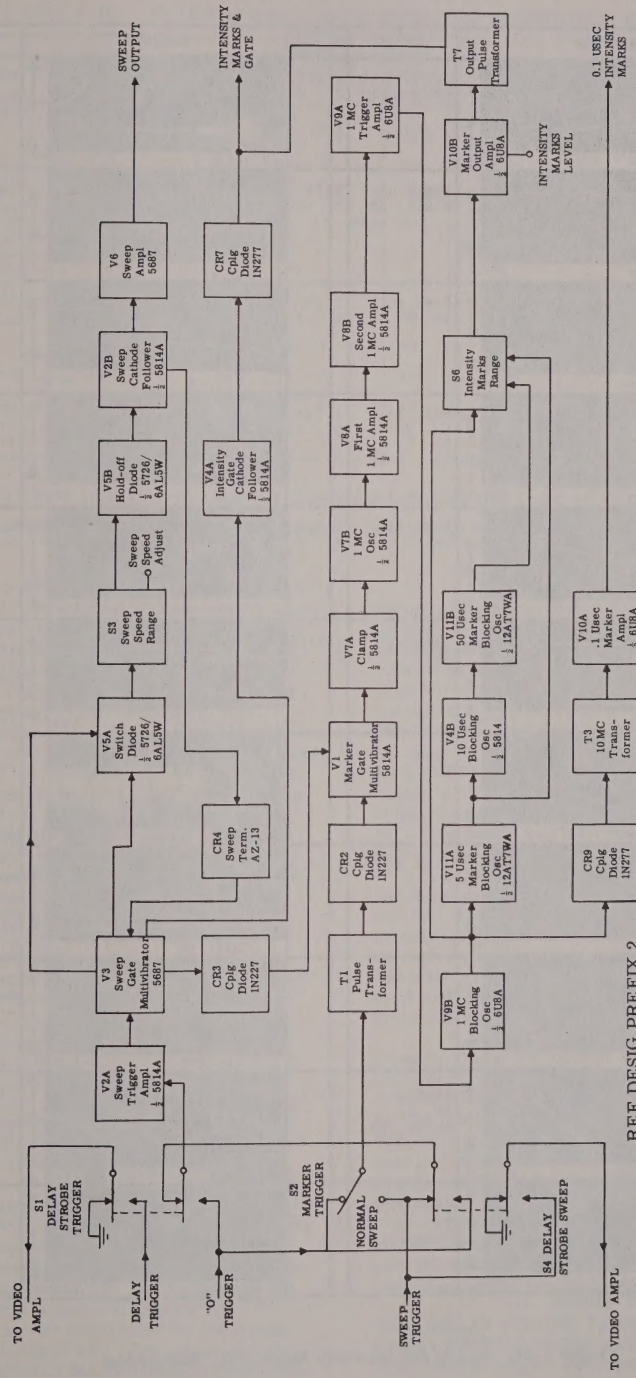


Figure 4-55. Sweep and Intensity Mark Unit, Block Diagram

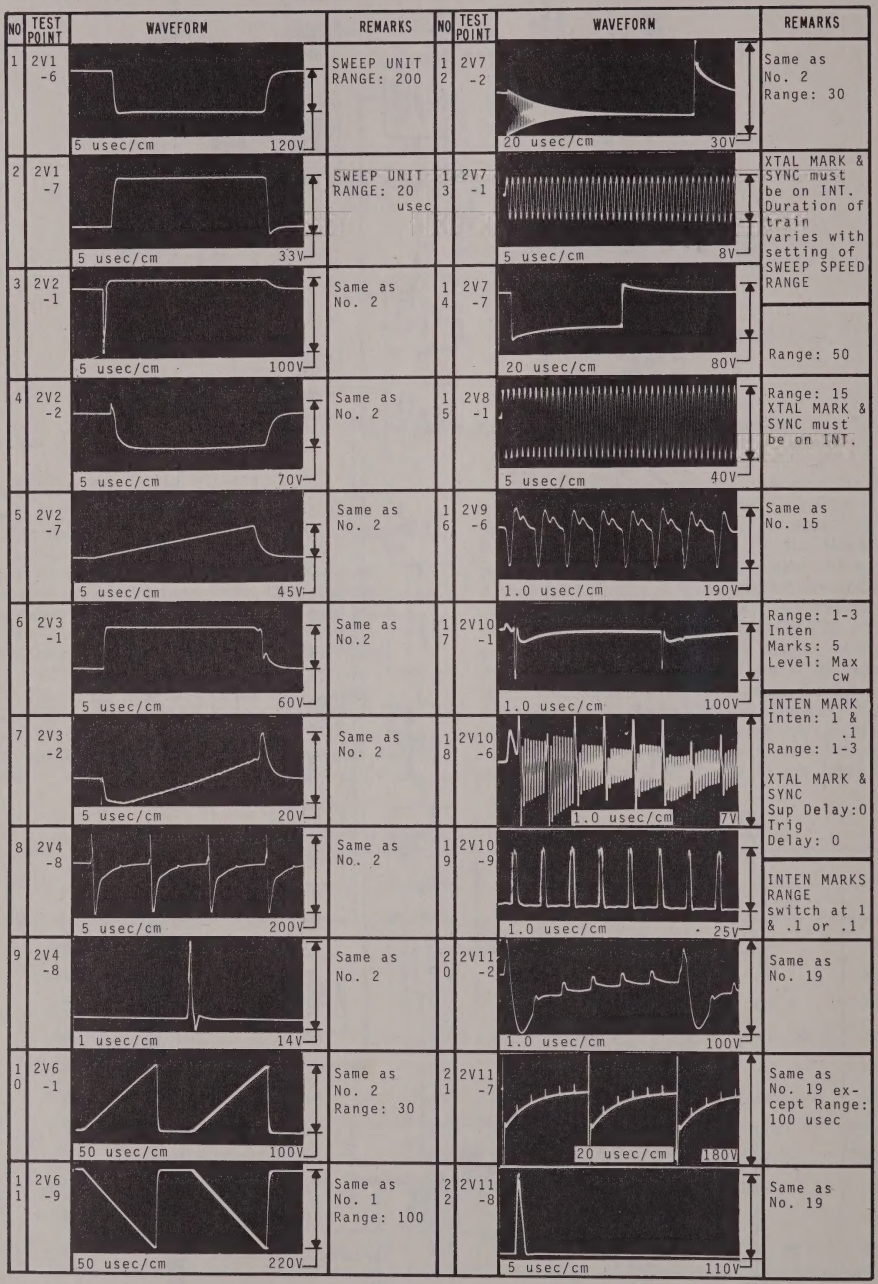


Figure 4-56. Sweep and Intensity Mark Unit, Waveforms

TABLE 4-10. SWEEP AND INTENSITY MARK UNIT RESISTANCE READINGS

Tube No.	Tube Pin Numbers								
	1	2	3	4	5	6	7	8	9
2V1	30K	1.5K △	-58	FIL	FIL	-50	-62	∞	40K
2V2	24K	45K	0	∞	∞	17K	∞	33K	∞
2V3	4.6K △	40K	--	12K	12K	19K	45K	--	4.7K △
2V4	17K	4.6K △	32K	∞	∞	17K	17K	68	∞
2V5	5K △	17K	∞	∞	∞	0	∞	--	--
2V6	40K	1.3 Meg	24K	∞	∞	26K	45K	∞	40K
2V7	18K	700	1.6K	∞	∞	29K	750K	700	∞
2V8	25K	330K	220	∞	∞	+92	0	1K	∞
2V9	17K	50K	33K	∞	∞	17K	0	470	12K
2V10	19.5K	0	27K	∞	∞	∞	180	0	140K
2V11	17K	--	150	∞	∞	17K	70K	190	∞

Note: 1. Resistance measurements taken to chassis ground with unit removed and disconnected.

2. △ Indicates that diode in circuit will cause readings to vary.

SWEEP SPEED RANGE switch 2S3 and the SWEEP SPEED ADJUST control 2R29 provide coarse and fine sweep duration adjustment. Sweep cathode follower 2V2B provides a low impedance sweep voltage output. The output from sweep cathode follower 2V2B is applied to the input of sweep amplifier 2V6. Push-pull sweep voltage from sweep amplifier 2V6 is sufficient to drive the horizontal deflection plates of the cathode ray tube in the Display unit of the test set.

The output from sweep gate multivibrator 2V3 is also supplied to marker gate multivibrator 2V1 through coupling diode 2CR3. When MARKER TRIGGER switch 2S2 is in the NORMAL position, 0 triggers are fed through switch 2S2 pulse transformer 2T1 and coupling diode 2CR2 to marker gate multivibrator 2V1. When the MARKER TRIGGER switch 2S2 is set to SWEEP, sweep trigger pulses replace the 0 trigger pulses. The trigger pulse to 2V1 through 2CR2 is a negative-going pulse which causes a negative-going gate pulse to be generated by 2V1 and fed to clamp tube 2V7A. When the sweep gate pulse generated by 2V3 ends, a negative pulse from 2V3 is fed to 2V1 which causes the negative marker gate pulse generated by 2V1 to end.

During the time that the negative marker gate is applied to clamp 2V7A, this tube cuts off and permits oscillator 2V7B to oscillate. 2V7B oscillates at a frequency of 1 mHz, generating the basic one-microsecond intensity markers, and is the reference for the 0.1, 5, and 50-microsecond intensity markers generated by the Sweep and Intensity Mark unit. The sinewave signal generated by 2V7B is amplified by 2V8A and 2V8B, and further amplified by one-megahertz trigger amplifier 2V9A. The output pulses of this stage are used to fire the one-megahertz blocking oscillator 2V9B. The output of this stage is fed to INTENSITY MARKS RANGE switch 2S6.

The output of 2V9B also drives five-microsecond blocking oscillator 2V11A and transformer 2T3 through coupling diode 2CR9. Output from 2V11A is fed to switch 2S6, and also to ten-microsecond blocking oscillator 2V4B, which divides the prf by two. The output of 2V4B then drives fifty microsecond marker blocking oscillator 2V11B which divides it by five. The output of 2V11B is fed to INTENSITY MARKS RANGE switch 2S6.

The one-microsecond pulses fed to transformer 2T3 cause the primary of this transformer to "ring" at its resonant frequency. The ten megahertz signal thus generated is amplified by 2V10A and fed out of the Sweep and Intensity Mark unit to the Display unit as 0.1 microsecond intensity markers.

INTENSITY MARKS RANGE switch 2S6 has six positions which are: OFF, .1, 1 & .1, 1, 5, and 50. These switch positions select the desired intensity markers to be fed to the Display unit through the subsequent stages, and in the case of the 0.1 microsecond intensity markers, by switching the plate voltage to the one-tenth microsecond marker amplifier 2V10A.

Intensity markers from switch 2S6 are fed to marker output amplifier 2V10B and output pulse transformer 2T7. The INTENSITY MARKS LEVEL control 2R95 provides adjustment of bias on 2V10B so that the 1, 5, or 50-microsecond (but not the 0.1) intensity marker amplitude can be adjusted. A positive sweep gate from 2V3 is fed through intensity gate cathode follower 2V4A and coupling diode 2CR7 to the same connection as the 1, 5, and 50-microsecond intensity markers. Thus the intensity markers applied to the Display unit are on the same gate pulse which illuminates the horizontal sweep and extinguishes the horizontal retrace.

(a) SWEEP TRIGGER AMPLIFIER. - When DELAY STROBE TRIGGER switch 2S1 and DELAY STROBE SWEEP switch 2S4 are both in their normal (upper) positions as shown in figure

4-57, sweep trigger input from the Crystal Mark and Sync unit is fed in through the closed switch contacts and coupled to the grid of sweep trigger amplifier 2V2A through capacitor 2C6.

Pressing DELAY STROBE TRIGGER switch 2S1 downward causes 0 trigger input from the Crystal Mark and Sync unit to be coupled to sweep trigger amplifier 2V2A through another set of closed contacts of switch 2S1 and through coupling capacitor 2C6. Delay trigger input from the Crystal Mark and Sync unit is attenuated by divider resistors 2R1 and 2R2 and fed to the video amplifier circuits of the Display unit through the switch contacts. This permits display of a negative delay trigger pulse on a zero delay sweep trace. Releasing the switch permits it to return to its normal (upper) position.

Pressing the DELAY STROBE SWEEP switch 2S4 downward causes 0 trigger input from the Crystal Mark and Sync unit to be coupled to the sweep trigger amplifier through the now closed contacts of switch 2S4, through the contacts of 2S1, and through coupling capacitor 2C6. Sweep trigger input from the Crystal Mark and Sync is attenuated by divider resistors 2R43 and 2R44 and fed to the video amplifier circuits of the Display unit through the 2S4 switch contacts. This permits the display of a positive sweep trigger pulse on a zero-delay sweep trace. Releasing the switch permits it to return to its normal (upper) position.

Positive trigger input to sweep trigger amplifier 2V2A produces an amplified negative trigger output which is used to trigger sweep gate multivibrator 2V3 (figure 4-58) and initiate a cycle of sweep operation. Sweep gate multivibrator 2V3 returns a negative gate pulse to the grid of sweep trigger amplifier 2V2A through resistor 2R10. This gates off sweep trigger amplifier 2V2A, making it inoperative during the sweep trace interval.

(b) SWEEP GATE MULTIVIBRATOR.- Sweep gate multivibrator 2V3 is shown in figure 4-58. The input trigger from sweep trigger amplifier 2V2A is applied to the first grid (pin 2) of the multivibrator. The first tube section cuts off, delivering a positive-going gate pulse through 2R26 to the cathode of switch diode 2V5A; and the second section goes into conduction, delivering a negative-going neutralizing pulse through 2C12 to the anode of switch diode 2V5A. The positive-going output from the cut off section also drives intensity gate cathode follower 2V4A. The negative-going pulse output from the plate load of the conducting section is also supplied to gate-off sweep trigger amplifier 2V2A during this sweep trace interval.

After one cycle, the multivibrator returns to its normal state; the first section conducting and the second section cut off. A positive 250-volt plate supply and a negative 150-volt cathode return provides an effective 400-volt plate supply. This arrangement permits clipper diodes 2CR5 and 2CR6 to clip positive-going plate pulses at approximately chassis ground potential (the pulse level required for operation of associated circuits).

(c) SWEEP GENERATOR CIRCUITS.- Before the arrival of a gate pulse at switch diode 2V5A, this diode is in a conductive state. During this time, sweep capacitor 2C17 is able to charge toward the +250 volt B+ potential through the path from ground consisting of 2R27, 2V5A, and 2R35 and 2R36 in parallel. The side of 2C17 connected to the grid of sweep cathode follower 2V2B is negatively charged. The potential at the cathode of 2V2B also becomes negative. This negative potential is coupled to the grid of the first section of sweep amplifier 2V6, to be amplified and used as a sweep voltage.

When a positive gate pulse from 2V3 is applied to the cathode of switch diode 2V5A, this diode is cut off, breaking the charging path to ground for 2C17. Capacitor 2C17 now starts to discharge. A discharge path is found through the contacts of SWEEP RANGE switch 2S3, through 2R31 (or other

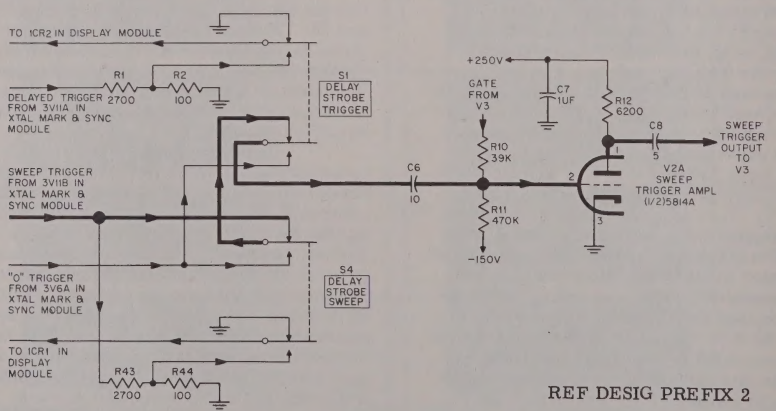


Figure 4-57. Sweep Trigger Amplifier, Simplified Schematic Diagram

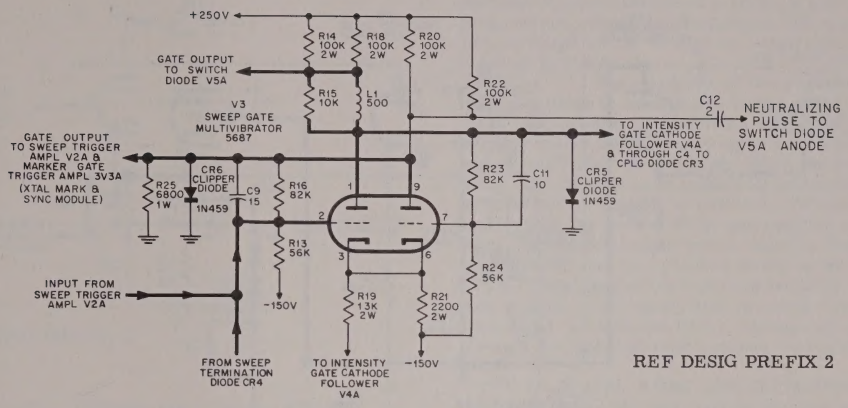


Figure 4-58. Sweep Gate Multivibrator, Simplified Schematic Diagram

resistors selected by 2S3, including variable resistor R29A or B), through hold-off diode 2V5B back to B+, and eventually to ground. Since the time constant of the discharge network is relatively long, capacitor 2C17 will discharge slowly, forming the slope of a sawtooth voltage pulse. The side of 2C17 connected to the grid of sweep cathode follower 2V2B gradually becomes more positive, causing 2V2B to increase conduction accordingly. The potential at the cathode of 2V2B also goes positive following the same pattern. This increasing positive voltage is coupled to the grid of the first section of sweep amplifier 2V6, to be amplified and used as a sweep voltage.

To terminate the sweep action, a portion of the 2V2B cathode voltage is tapped off the cathode load (from 2R33) and returned to the grid of the first section of sweep gate multivibrator 2V3 through sweep terminating diode 2CR4. When the voltage reaches the proper positive level, it causes the first section of the multivibrator to conduct and the second section to cut off, thus terminating the sweep gate. SWEEP AMP potentiometer 2R33 permits adjustment of the amplitude of the voltage picked off, thus adjusting the sweep gate and thus the sweep length.

When SWEEP SPEED RANGE switch 2S3 is in the 1-3 position (as shown in figure 4-59) SWEEP SPEED ADJUST control 2R29B is in the discharge circuit, and the sweep time is variable from one to three microseconds. When the switch is in the 1-30 position, the circuit is the same except that 2R29A is substituted for 2R29B, giving a sweep time up to 30 microseconds. In the next three switch positions, additional capacitors are switched into the circuit to obtain longer time constants and the associated longer sweep times.

(d) SWEEP AMPLIFIER. - Sweep cathode follower 2V2B drives the grid of sweep amplifier 2V6 as shown in figure 4-60. The positive 250-volt plate supply and the negative 150-volt supply provide a 400-volt plate-to-cathode potential for this stage. While providing a high effective plate supply voltage, this arrangement also results in operating plate voltages which permit the use of a direct-coupled output circuit.

When an increasingly positive sweep potential from 2V2B is applied to the grid (pin 7) of the first section of sweep amplifier 2V6, conduction is increased and the potential at the plate (pin 9) of that section becomes increasingly negative. This voltage is fed out as one of the sweep voltages. The second section of 2V6 is cathode-fed from the cathode of the first section, thus it acts as an inverter stage (inverting with respect to the waveform at the first plate); its conduction decreases and the output goes correspondingly positive. The two opposing sweep outputs are used to drive a push-pull deflection system. The dc bias on the grid of the second section of 2V6 (provided by the -150 volt supply) is variable by means of the HOR control located on the Display unit. This permits centering the sweep trace on the CRT. Capacitor 2C22 provides a signal grounding path for the grid of this stage. Capacitor 2C21 acts as a decoupling capacitor for the -150 volt line.

(e) INTENSITY GATE CATHODE FOLLOWER. - The purpose of intensity gate cathode follower 2V4A (figure 4-61) is to permit a trace to be displayed during the horizontal sweep, and to blank out the retrace.

(f) MARKER GATE MULTIVIBRATOR. - Marker gate multivibrator 2V1 is a bistable multivibrator with symmetrical grid and plate circuits (figure 4-62). Under static conditions, 2V1A (pins 1, 2, and 3) is conducting and 2V1B (pins 6, 7, and 8) is cut off. When the positive 0 trigger or sweep trigger pulse is applied to the circuit, it is routed through MARKER TRIGGER switch 2S2, resistors 2R104, 2R105 and 2R106 and transformer 2T1 to the grid of 2V1A. The transformer inverts the pulse so the negative pulse causes 2V1A to cut

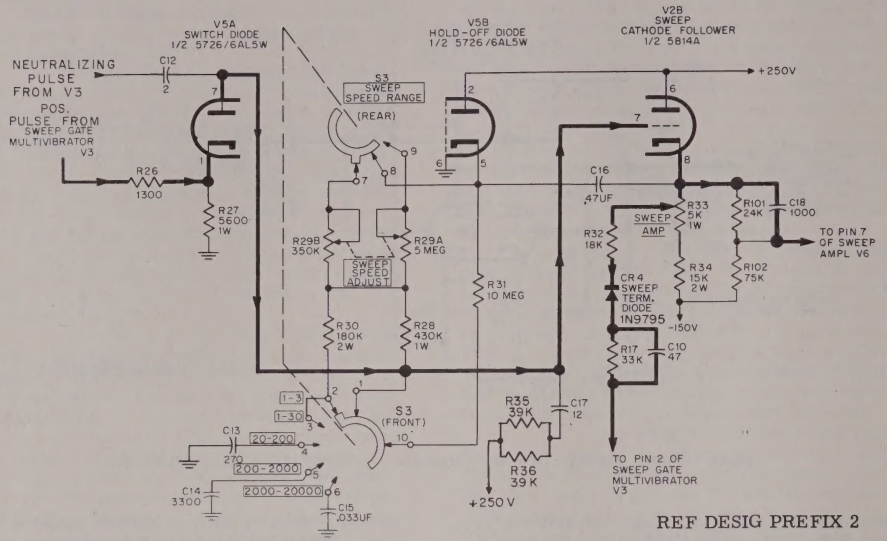


Figure 4-59. Sweep Generator, Simplified Schematic Diagram

off, driving 2V1B into conduction. The output at the plate of 2V1B is a negative-going rectangular marker gate pulse. This plate potential remains low, continuing the negative-going gate pulse, until the negative-going sweep gate trailing edge from the first plate (pin 1) of sweep gate multivibrator 2V3 arrives at the 2V1B grid (pin 7) through 2C4 and coupling diode 2CR3. At this time 2V1B cuts off and the negative-going marker gate pulse being generated at the 2V1B plate (pin 6) is ended. The width of this marker gate is adjustable from approximately one microsecond to approximately 20,000 microseconds, depending upon the sweep duration and sweep delay.

Coupling diodes 2CR2 and 2CR3 prevent unwanted pulses of the wrong polarity from feeding back to the circuits which feed the marker

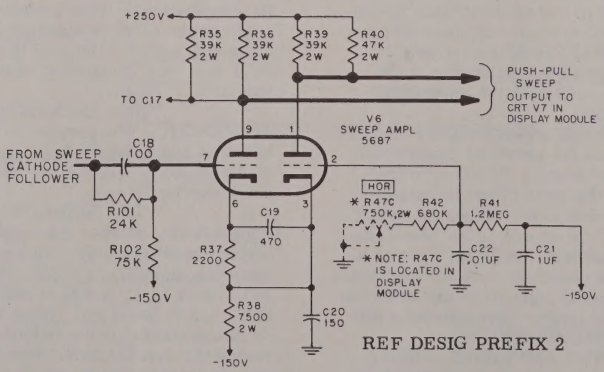


Figure 4-60. Sweep Amplifier, Simplified Schematic Diagram

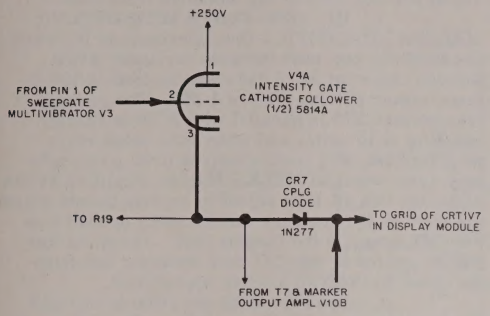


Figure 4-61. Intensity Gate Cathode Follower, Simplified Schematic Diagram

gate multivibrator. Pulse transformer 2T1 is used as a coupling and inverting device between the marker gate multivibrator and the sweep trigger sources.

(g) CLAMP AND ONE MHZ OSCILLATOR. - The clamp and 1 mHz oscillator are comprised of a twin triode tube 2V7 (see figure 4-63). The purpose of these two stages is to generate and control 1 mHz oscillations. The 1 mHz signal is the source of the one microsecond pulses used as intensity markers on the CRT, and also as a reference for the 0.1, 5, and 50-microsecond intensity markers.

One mHz oscillator 2V7B is basically a Hartley oscillator circuit with the refinements necessary for the required stability. A feedback adjustment, 2R50 is provided to permit adjustment for constant output amplitude. The oscillator tank circuit consisting of 2L2 and 2C27 is enclosed in a thermostatically controlled oven for a high degree of temperature stability. Thermostat 2S5 maintains an oven temperature of 85 degrees centigrade (185 degrees Fahrenheit).

The operation of the clamp and one mHz oscillator is as follows: Under static conditions, one mHz oscillator 2V7B will not oscillate because clamp 2V7A is drawing heavy cathode current through tank coil 2L2. When the negative-going gate pulse from marker gate multivibrator 2V1 arrives, 2V7A cuts off and 2V7B is allowed to oscillate. Since the grid of 2V7B was positive at the start, oscillation begins with a negative swing at the grid of 2V7B and on a positive swing at the plate of 2V7A. This oscillation continues until the negative gate applied to the clamp tube is ended. At this time 2V7A again draws heavy cathode current through the tank coil which causes the oscillation to stop.

(h) FIRST AND SECOND ONE MHZ AMPLIFIERS. - The first and second one mHz amplifiers are in a single twin triode tube, 2V8 (see figure 4-64). These triodes are capacitance-coupled and provide a combined gain of approximately 15. Since the two stages are cascaded, the output polarity of the second stage is the same as the input polarity of the first stage. Output from second stage 2V8B is fed to clipper diode 2CR8 through coupling capacitor 2C32 and then to 1 mHz trigger amplifier 2V9A.

(i) ONE MHZ TRIGGER AMPLIFIER AND BLOCKING OSCILLATOR. - Trigger amplifier 2V9A and blocking oscillator 2V9B are in a single tube envelope (figure 4-65). Under static conditions, the 2V9A grid is biased with approximately -5 volts, and the 2V9B grid is biased beyond cutoff with -35 volts. When the signal from the second one megahertz amplifier is fed to 2V9A, clipper diode 2CR8 clips the negative portion of this signal.

This clipped signal is amplified by 2V9A and applied to the grid circuit of 2V9B through

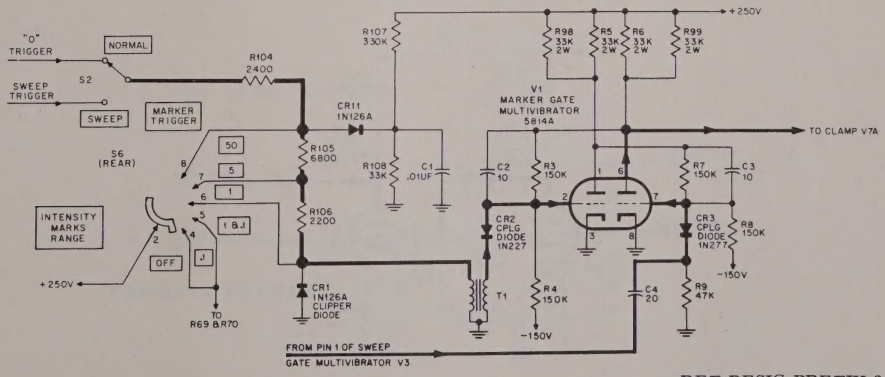


Figure 4-62. Marker Gate Multivibrator, Simplified Schematic Diagram

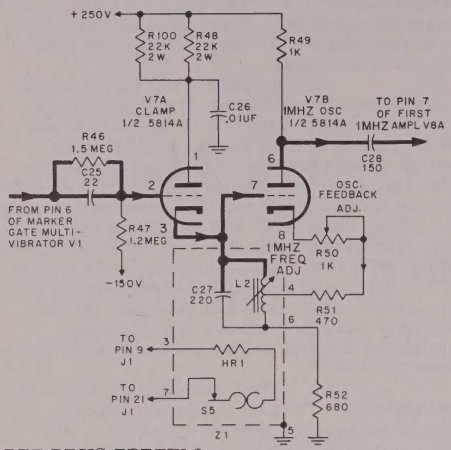


Figure 4-63. Clamp and 1 mHz Oscillator, Simplified Schematic Diagram

blocking oscillator transformer 2T2. At this time blocking oscillator 2V9B fires and produces a positive-going pulse across its cathode load resistor 2R64.

The positive-going output pulses of 2V9B are fed to switch 2S6 for application to the cathode ray tube in the Display unit as one-microsecond intensity markers. The one-microsecond pulses are also fed to the 0.1 and 5-microsecond marker generator circuits to initiate these markers.

Clipper diode 2CR10 in series with resistor 2R67 is placed across the secondary winding of blocking oscillator transformer 2T2 to prevent circuit ringing. This feature assures that the output signal will not contain any unwanted transients.

(j) ONE-TENTH MICROSECOND MARKER AMPLIFIER. - One-microsecond markers are fed from one mHz blocking oscillator 2V9B through capacitor 2C35 and coupling diode 2CR9 to transformer 2T3 (see figure 4-66). The primary of transformer 2T3 in parallel with 2C36 is sharply resonant at 10 mHz, and when fed a pulse every microsecond, will continuously deliver a ten mHz sine wave output to 2V10A. Marker amplifier 2V10A amplifies this 10 mHz signal to provide pulses which are used as 0.1 microsecond intensity markers on the CRT sweep in the Display unit. These marker pulses are fed to the CRT on a separate line from the other markers to prevent degradation.

Resistor 2R69 and peaking coil 2L3 are the plate load for the amplifier. The voltage gain of this stage is approximately four. The output from this stage is fed to the CRT in the Display unit through internal connections.

(k) FIVE-MICROSECOND MARKER BLOCKING OSCILLATOR. - Five-microsecond blocking oscillator 2V11A is non-conducting under static conditions due to a negative cutoff bias from the voltage divider consisting of 2R76 and 2R74 (figure 4-67A). This circuit is driven by positive-going one-microsecond pulses from one mHz blocking oscillator 2V9B. When the oscillator tube conducts, a positive pulse is developed across cathode load resistor 2R77. These positive output pulses are fed to switch 2S6 for application to Marker amplifier 2V10B and then to the CRT in the Display unit as five-microsecond intensity markers. These positive five-microsecond pulses also drive the 10-microsecond blocking oscillator 2V4B.

(l) TEN-MICROSECOND AND FIFTY-MICROSECOND BLOCKING OSCILLATORS. - The positive pulse output from the five microsecond blocking oscillator 2V11A is used to drive the ten-microsecond blocking oscillator 2V4B, which in turn drives the fifty-microsecond blocking oscillator 2V11B, (figure 4-67B). In this manner a count-down of two to one (division by 2) followed by a

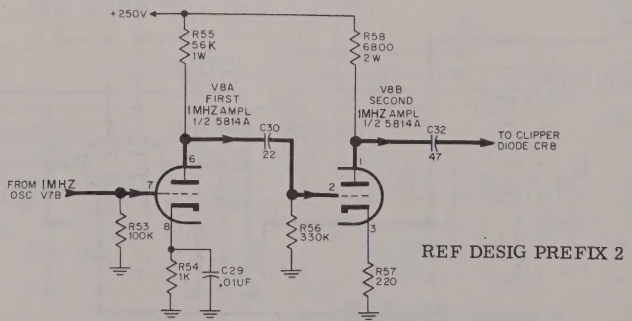


Figure 4-64. 1st and 2nd 1 mHz Amplifier, Simplified Schematic Diagram

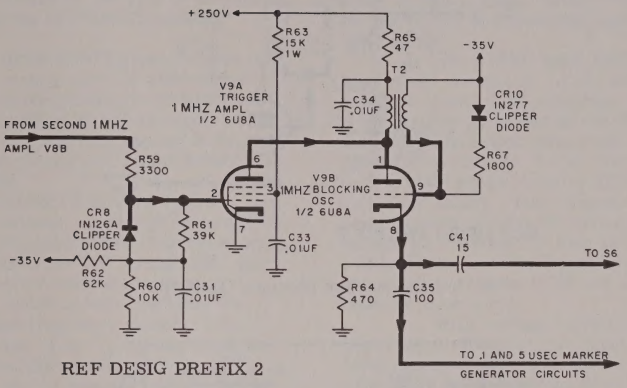


Figure 4-65. .1 mHz Trigger Amplifier and Blocking Oscillator, Simplified Schematic Diagram

count-down of five to one produces an over-all count-down of ten to one (from the five-microsecond blocking oscillator to the fifty microsecond blocking oscillator). Both ten-microsecond blocking oscillator 2V4B and fifty microsecond blocking oscillator 2V11B are biased beyond cutoff in their static conditions and driven into conduction by the positive input pulses. There is no provision for adjusting the grid circuit time-constant in 2V4B since the count-down is only two to one. However, fifty-microsecond blocking oscillator 2V11B has 50 usec adjust potentiometer 2R86 in its grid circuit so that the count-down of this stage may be adjusted to exactly five to one.

The output from 2V11B is obtained from across the cathode load resistor 2R91. The output at this point is a positive-going pulse signal which is fed to switch 2S6 and marker output amplifier 2V10B to produce 50-microsecond intensity markers for use in the Display unit.

(m) MARKER OUTPUT AMPLIFIER. - Marker output amplifier 2V10B (figure 4-67C) contains INTENSITY MARKS RANGE switch 2S6 in its grid circuit for selection of the various intensity markers for application to intensity gate cathode follower 2V4A. Marker output amplifier 2V10B is biased beyond cutoff. INTENSITY MARKS LEVEL control 2R95 allows the operator to adjust this bias between approximately -20 and -45 volts. Application of the positive-going markers causes 2V10B to

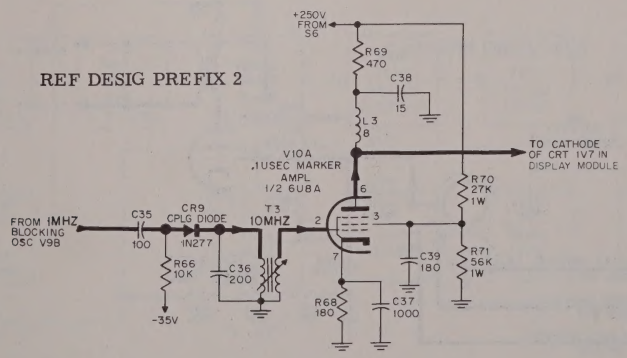
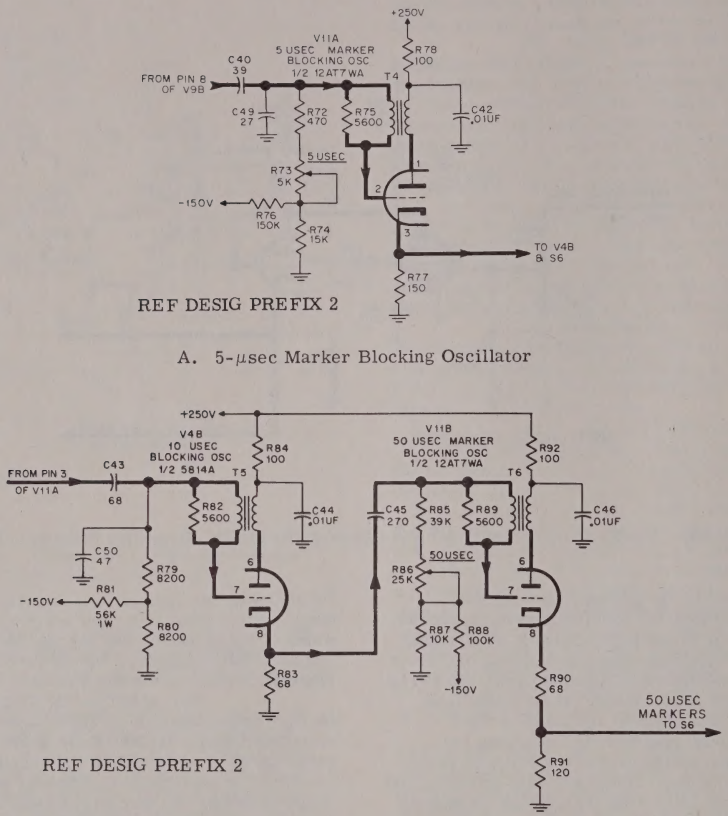
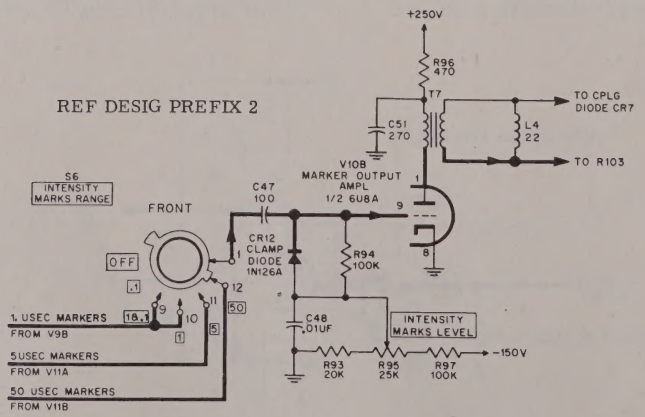


Figure 4-66. 0.1-usec Marker Amplifier, Simplified Schematic Diagram



A. 5-μsec Marker Blocking Oscillator

B. 10-μsec and 50-μsec Marker Blocking Oscillator



C. Marker Output Amplifier

Figure 4-67. Marker Blocking Oscillator and Output Circuits, Simplified Schematic Diagram

conduct for the duration of the pulse and produce in its plate circuit a sharp spike by means of pulse transformer 2T7. The output pulse amplitude will be reduced as the negative bias on the grid of the tube is increased by means of the INTENSITY MARKS LEVEL control.

Clamp diode 2CR12 prevents grid leak bias from developing across resistor 2R94 in the event the incoming positive pulses are of sufficient amplitude to drive the grid of 2V10B positive. This is necessary because the only bias applied to the grid of 2V10B is the bias at the arm of the INTENSITY MARKS LEVEL control.

The INTENSITY MARKS RANGE switch 2S6 has five positions. It should be noted that when the switch is placed in the .1 position no 0.1 microsecond markers are fed through 2S6, but the routing of the 0.1 microsecond markers is through another path, which is more suitable for transmission of the high frequency pulses. When the switch is in the 1 and .1 or 1 position, 1 microsecond markers are fed through the switch. (In either the .1 or the 1 and .1 position, +250 volts is switched to the one-tenth microsecond marker amplifier 2V10A by other contacts of the same switch, thus enabling this stage to function.) When 2S6 is in the 5 or 50 position, the appropriate markers are fed through and +250 is switched to the proper stages.

(3) DISPLAY UNIT. - The circuit functions of the Display unit are shown in figure 4-68 and are described below. Display unit waveforms are given in figure 4-69, voltage measurements are given in table 4-11, and resistance readings are given in table 4-12.

The VIDEO input jack 1J1 (figure 4-70) is a front panel connector. A 75-ohm termination can be switched in or out as required. Video gain adjustment is made by means of the VOLTS/IN (volts-per-inch) step attenuator switch and the VIDEO SENS (sensitivity) control. First video amplifier 1V2B also drives video phase inverter 1V1A to provide a push-pull video output. Four stages of push-pull video amplification provide the required vertical deflection voltage for cathode ray tube 1V7. Coupling diodes 1CR1, 1CR2, and 1CR3 apply video mark pulses to video driver triodes 1V3B and 1V4A to provide a baseline time scale.

High voltage oscillator 1V8 provides ac power for an rf-type power supply. Negative 1500 volts from rectifier 1V9 and positive 1500 volts from rectifier 1V10 in combination provide a 3000-volt supply for cathode ray tube 1V7. Output from oscillator 1V8 is rectified by bias rectifier 1CR5 and 1CR6, providing bias for cathode ray tube intensity control.

The SCALE control 1R59B adjusts the brightness of reticle illumination lamp 1DS1. The

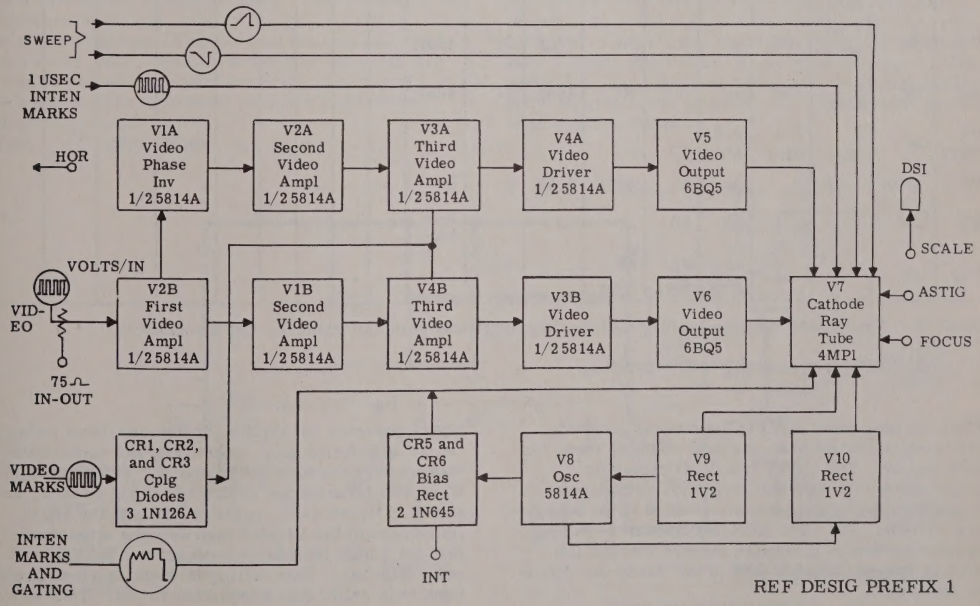


Figure 4-68. Display Unit, Block Diagram

TABLE 4-11. DISPLAY UNIT VOLTAGE READINGS

Tube	TUBE PIN NUMBERS																	
No.	1	2	3	4	5	6	7	8	9	10	11	12	D1	D2	D3	D4	A1	A2
1V1	+250	+108	+110	FIL	FIL	+107	0	+1.8	FIL	--	--	--	--	--	--	--	--	--
1V2	0	+108	+18	FIL	FIL	+210	+107	+110	FIL	--	--	--	--	--	--	--	--	--
1V3	+82	0	+0.73	FIL	FIL	+200	+81	+84	FIL	--	--	--	--	--	--	--	--	--
1V4	+81	0	+0.73	FIL	FIL	+210	+82	+85	FIL	--	--	--	--	--	--	--	--	--
1V5	NC	+3.25	+10.4	FIL	FIL	NC	+170	NC	+250	--	--	--	--	--	--	--	--	--
1V6	NC	+3.6	+10.4	FIL	FIL	NC	+155	NC	+250	--	--	--	--	--	--	--	--	--
1V7 (CRT)	FIL	-1500	-1440	-1030	--	--	--	--	--	--	--	FIL	+180	+83	+170	+150	+1500	+155
1V8	+235	-2.2	0	FIL	FIL	+235	-22	0	FIL	--	--	--						
1V9	--	--	--	0	0	-1460	--	--	--	--	--	--						
1V10	0	--	--	+1500	+1500	+1500	--	--	--	--	--	--						

TABLE 4-12. DISPLAY UNIT RESISTANCE READINGS

Tube	TUBE PIN NUMBERS																	
No.	1	2	3	4	5	6	7	8	9	10	11	12	D1	D2	D3	D4	A1	A2
1V1	480K	480K	480K	∞	∞	480K	0	120	∞	--	--	--						
1V2	480K	2.5K	120	∞	∞	480K	480K	480K	∞	--	--	--						
1V3	480K	2.2 Meg	70	∞	∞	480K	480K	6K	∞	--	--	--						
1V4	480K	2.2 Meg	70	∞	∞	480K	480K	6K	∞	--	--	--						
1V5	NC	1.3 Meg	150	∞	∞	NC	480K	NC	480K	--	--	--						
1V6	NC	1.1 Meg	150	∞	∞	NC	480K	NC	480K	--	--	--						
1V7 (CRT)	∞	8 Meg	5.6 Meg	3.8 Meg	--	--	--	--	--	--	--	∞	∞	∞	480K	480K	45 Meg	380K
1V8	480K	2.3K	0	∞	∞	480K	2.3K	0	∞	--	--	--						
1V9	--	--	--	80	80	--	--	--	5.5 Meg	--	--	--						
1V10	80	--	--	45 Meg	45 Meg	45 Meg	--	--	--	--	--	--						

Notes: 1. Resistance measurements taken to chassis ground with unit removed and disconnected.

2. All panel controls in ccw position.

ASTIG (astigmatism) and FOCUS control potentiometers adjust the cathode ray tube voltages from the power supply. The VERT (vertical) centering control adjusts the vertical deflection voltages on the display tube by the control action of video output tubes 1V5 and 1V6. The HOR (horizontal) centering control functions in a similar manner through the action of sweep amplifier 2V6 in the Sweep and Intensity Mark unit.

(a) VIDEO INPUT CIRCUIT. - When 75Ω termination switch 1S1 is set to IN (figure 4-70) the 75 ohm resistor 1R6 is connected across VIDEO input connector 1J1 on the Display unit front panel. (Pulse waveforms can be observed and amplitudes measured at the terminated end of a video cable.) When 75Ω termination switch 1S1 is set to OUT, as shown in figure 4-70, resistor 1R1 and the shunt impedance of the Display module input attenuator present a high impedance load across VIDEO input connector 1J1. This setting is used for video probe input with calibrated attenuation ratios. This setting can also be used for direct video input to the Display unit input attenuator.

When VOLTS/IN (volts per inch)

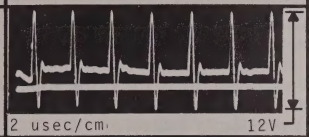
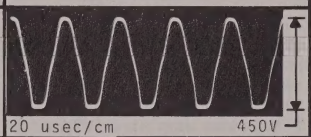
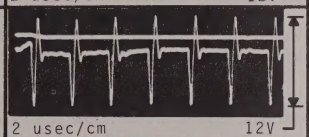
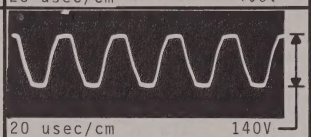
NO	TEST POINT	WAVEFORM	REMARKS	NO	TEST POINT	WAVEFORM	REMARKS
1	1V5 -7		XTAL MARK on INT:1.00 XTAL MARKS LEVEL fully cw	3	1V8 -1		Approx. 30KC
2	1V6 -7		Same as No. 1	4	1Z1 -6		Varies with setting of Intensity Control Approx. 30KC

Figure 4-69. Display Unit, Waveforms

switch 1S2 is set to .05, video input is coupled directly through capacitor 1C4 and the contacts of switch 1S2 to the grid (pin 2) of first video amplifier 1V2B. Input loading and grid return is provided by resistor 1R11. Direct connection provides a one-to-one attenuation ratio, and the greatest vertical deflection sensitivity 0.05 volts per inch. (The video probe when used in this position provides a choice of overall sensitivities of 0.05, 0.5, and 5 volts per inch.)

When VOLTS/IN switch 1S2 is set to .1, (figure 4-70) video input is coupled through capacitor 1C4 and the contacts of switch wafer 1S2C to an attenuator network. Resistors 1R4 and 1R5 form a two-to-one voltage divider. The attenuator network output is connected to the grid (pin 2) of first video amplifier 1V2B through the contacts of switch wafer 1S2B. Unused attenuator networks are shorted to chassis ground through the contacts of switch wafer 1S2A to prevent possible interaction through stray capacitance.

When VOLTS/IN switch 1S2 is set to .2, the basic circuit functions are the same as those for a switch setting of .1 described in the preceding paragraph. However, a four-to-one attenuator network is switched into the circuit. Similarly, attenuation switch settings of .5, 1, 2, 5, 10, and 20 provide attenuation ratios of 10:1, 20:1, 40:1, 100:1, 200:1, and 400:1, respectively. The output signal from the attenuator is amplified by first video amplifier 1V2B and the plate output is fed to second video amplifier 1V1B (figure 4-70). First video amplifier 1V2B also functions as a cathode follower which drives video phase inverter 1V1A. Since the cathode follower has no phase inversion, the 1V1A output is inverted with respect to that obtained from the plate of first video amplifier 1V2B, which does have a phase inversion. First video amplifier 1V2B and video phase inverter 1A1A are direct-driven and their outputs serve as push-pull video signals for the stages which follow.

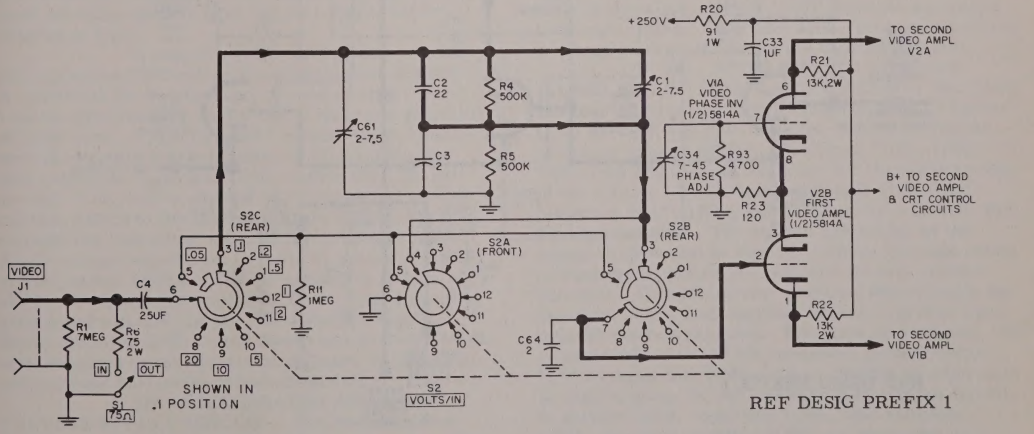


Figure 4-70. Video Input Circuit, Simplified Schematic Diagram

(b) VIDEO AMPLIFIER CIRCUIT.- Second video amplifer 1V1B and second video amplifier 1V2A function as a push-pull video amplifier as shown in figure 4-71. The use of push-pull tube sections in different envelopes prevents capacitance coupling effects. Frequency adjust capacitor 1C36 and resistors 1R28, 1R94 are used for negative feedback from third video amplifer 1V4B to second video amplifer 1V1B.

Third video amplifier 1V3A develops cathode bias across resistor 1R33 and third video amplifier 1V4B develops cathode bias across resistor 1R35. The two cathodes are separated by resistor 1R34 to permit separate input coupling to the cathodes. Coupling diode 1CR1 and resistor 1R62 provide sweep strobe coupling to the cathode to third video amplifier 1V3A to permit display of the delayed sweep trigger on a zero delay sweep trace. Coupling diode 1CR3 and resistor 1R64 provide crystal marker pulse coupling to the cathode of third video amplifier 1V3A to produce 1.00 or 1.45 microsecond markers on the sweep trace. Push-pull video output from third video amplifier 1V3A/1V4B is direct-coupled to the grids of video driver 1V4A/1V3B.

Video driver 1V4A/1V3B functions as a conventional push-pull video amplifier with gain control provided by cathode degeneration. Cathode bias for 1V4A is developed across resistor 1R37. Increased series resistance increases degeneration and reduces stage gain. Gain Cal adjustment 1R40 is a maintenance adjustment for calibration of video deflection sensitivity. VIDEO SENS control 1R41 is a front-panel sensitivity control.

(c) VIDEO OUTPUT AND DISPLAY CIRCUIT.- Video output amplifier 1V5/1V6 is a conventional amplifier with negative feedback provided by resistors 1R43 and 1R45 and load compensation provided by the two series peaking coils which make up 1T2 shunted by resistors 1R65 and 1R66 (figure 4-72). The push-pull video output is sufficient to drive the vertical deflection plates of cathode ray tube 1V7. Resistor 1R44 and VERT potentiometer 1R47AA act as a voltage divider for the positive grid bias for video output tube 1V5 through 1R46 while resistor 1R44 and VERT potentiometer 1R47AB act as a voltage divider for the positive bias for video output tube 1V6 through 1R48.

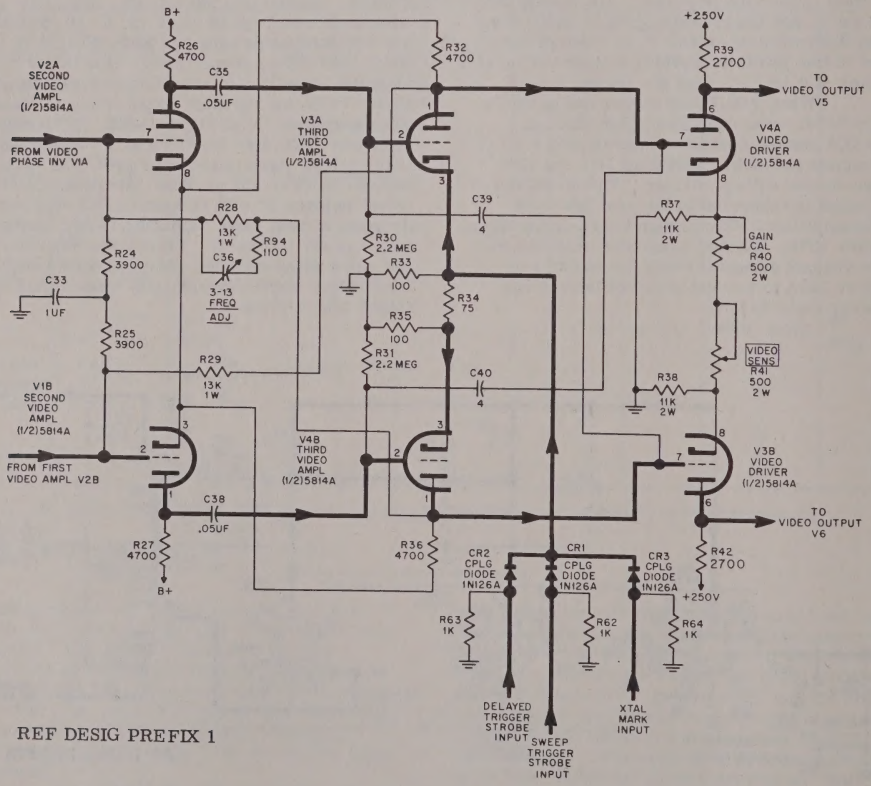


Figure 4-71. Video Amplifier Circuit, Simplified Schematic Diagram

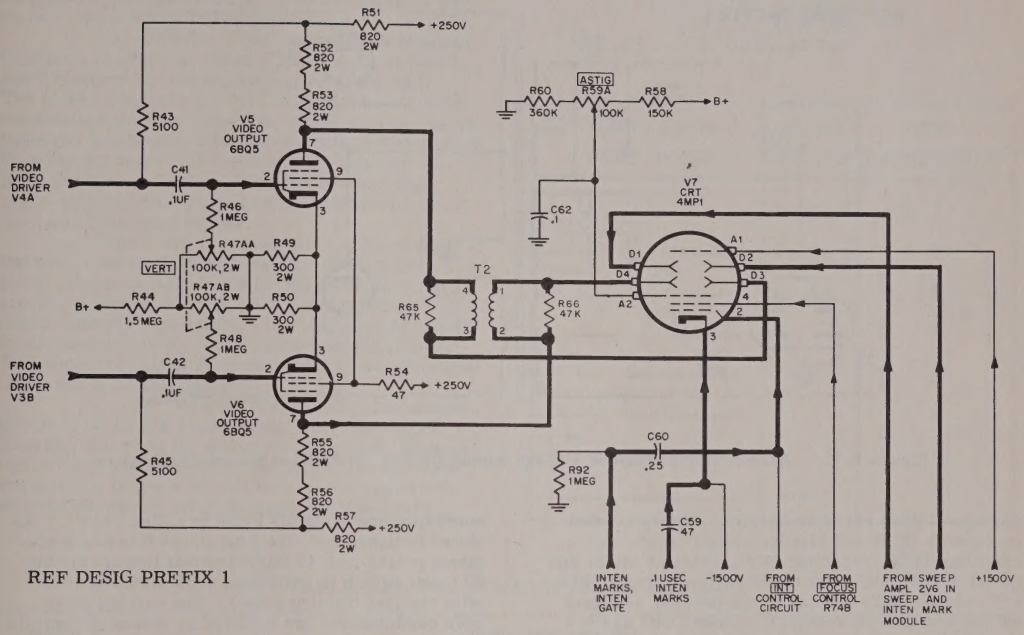


Figure 4-72. Video Output and Display Circuits, Simplified Schematic Diagram

VERT control 1R47 shifts the bias (and thus the plate voltage) on the output tubes in opposite directions. The output tube plate voltage is direct-coupled to the cathode ray tube vertical deflection plates for vertical centering purposes. The cathode ray tube 1V7 used for video display is of the post-deflection acceleration type.

A negative 1500-volt cathode potential and a positive 1500 volt post-deflection accelerator A1 potential (with respect to chassis ground), provide an effective post-deflection accelerator potential of 3000 volts. Capacitor 1C59 couples the 0.1 microsecond intensity marker pulses to the cathode ray tube cathode. Capacitor 1C60 couples the 1 microsecond, 5 microsecond, and 50 microsecond intensity marker pulses to the intensity-modulation grid of the cathode ray tube along with the intensity gate pulses. Anode voltage adjustment is made by means of ASTIG potentiometer 1R59A. The intensity grid and focus electrode voltages are obtained from control circuits associated with the rf-type anode voltage supply. Sweep amplifier 2V6, in the Sweep and Intensity Mark unit, supplies sweep deflection voltages for the cathode ray tube horizontal deflection plates.

(d) ACCELERATOR AND ANODE VOLTAGE SUPPLY CIRCUIT. - The rf-type power supply, shown in figure 4-73, is the dc power source for cathode ray tube 1V7. Oscillator 1V8 functions as a 40 kHz power source with output adjustment provided by anode set potentiometer 1R70. Transformer 1T1 supplies voltage to the two half-wave rectifiers. Rectifier 1V9 supplies a negative 1500-volt circuit while rectifier 1V10 supplies a positive 1500-volt circuit to meet the 3000-volt post-deflection accelerator requirement of the cathode ray tube.

(e) ACCELERATOR VOLTAGE FILTER AND INTENSITY BIAS CIRCUIT. - The filter and bias circuits are shown in figure 4-74. Plug-in filter network 1Z1 and capacitor 1C58 filter the accelerator voltage supply. Resistors 1R79, 1R80, 1R81, and 1R82 act as a bleeder for the positive side of the circuit. FOCUS potentiometer 1R74B and resistors 1R87, 1R90, and 1R91 act as a bleeder for the negative side. The voltage center-tap of the supply is grounded so that the cathode ray tube anode and deflection plates are near the chassis ground potential. Cathode return resistor 1R88 permits the insertion of 0.1 microsecond intensity marker input into the cathode ray tube. The plate of oscillator 1V8 is also coupled to INTEN (intensity) potentiometer 1R74 by capacitor 1C46. This provides an adjustable ac input voltage for the intensity bias control circuit. Capacitor 1C50, capacitor 1C56, bias rectifier 1CR5, and bias rectifier 1CR6 are connected as a

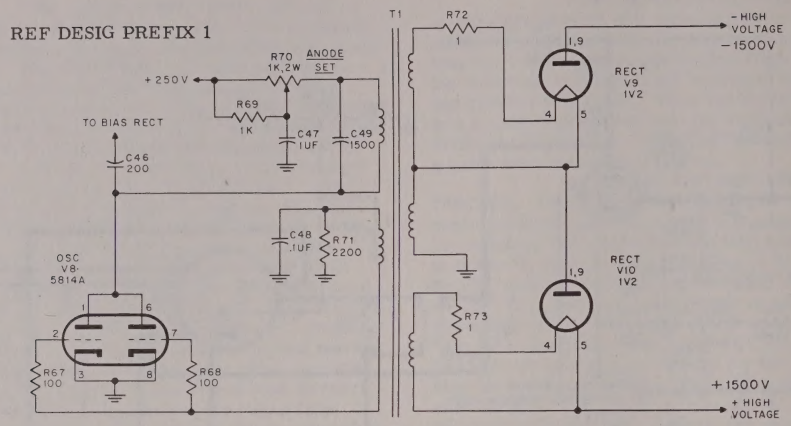


Figure 4-73. Accelerator and Anode Voltage Supply Circuit, Simplified Schematic Diagram

voltage-doubler rectifier system. The associated pi-network filter and bleeder circuit consists of capacitor 1C56, capacitor 1C57, resistor 1R83, and resistor 1R86. Clipper diode 1CR7, resistor 1R84, and resistor 1R85 are in the cathode ray tube grid return path as a dc restorer. Diode 1CR7 and resistor 1R84 provide sufficiently fast recovery to prevent cathode ray tube cut-off on high repetition rates.

(4) SIF CODER.-The SIF (Selective Identification Feature) code train generated by the SIF Coder consists of two framing pulses, up to 12 information pulses, and when selected, either an X pulse or an ID pulse. (In mode C the pulse corresponding to the ID Pulse is called "SPI".) As shown in figure 3-2, the time interval between adjacent pulses is 1.45 microseconds (except for the ID pulse, which is positioned 4.35 microseconds after the last framing pulse). The various pulse code combinations are selected by means of controls on the front panel of the SIF Coder.

The twelve information pulses are each positioned in time with reference to the first framing pulse. They are divided into four interlaced groups (A, B, C, D) associated with the four digits of the standard SIF numbers. Each group has three pulses and each pulse of the group is spaced 2.90 microseconds from the others. Each pulse is

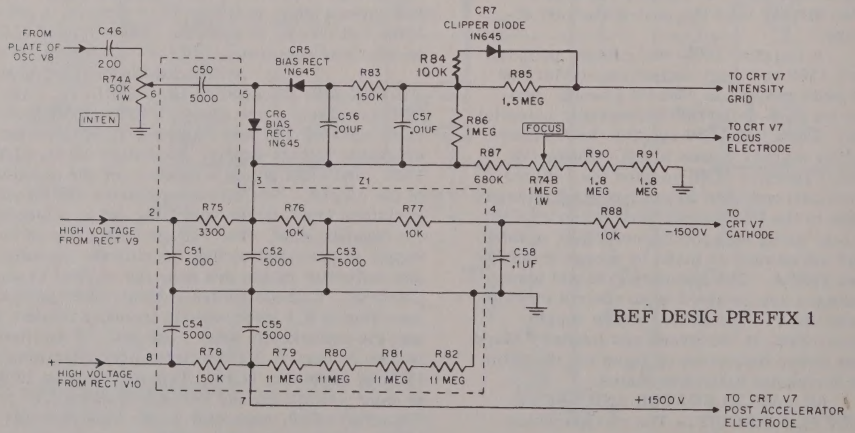


Figure 4-74. Accelerator Voltage Filter and Intensity Bias Circuit, Simplified Schematic Diagram

identified by a number (1, 2, or 4) referring to its value in the binary number system.

For example: Code number 2435 consists of pulse 2 of group A, pulse 4 of group B, pulses 1 and 2 of group C, and pulses 1 and 4 of group D. The pulse code train for 2435 will, therefore, have information pulses at the first, third, fourth, eighth, eleventh, and twelfth information pulse positions (not counting the unused "X" space as an information pulse position). Table 4-13 shows how the digit represented by each pulse group is obtained from the sum of the pulse values.

Since there is a possibility of eight digits (0 through 7) for each group, and the digits of each group can be combined with the digits of the other groups, a total of 4096 (8 x 8 x 8 x 8) different coded numbers is possible. The train having pulses in all information positions represents the number 7777 while the train having no pulses in any information position represents 0000.

(a) BLOCK DIAGRAM. - The circuit functions of the SIF Coder are shown in the block diagram, figure 4-75, and in the schematic diagram, figure 5-63, and are described below. Waveforms are given in figure 4-76 and voltage and resistance measurements are given in tables 4-14 and 4-15.

TABLE 4-13. CODING OF DIGITS IN GROUPS A, B, C, AND D

PULSE TRAIN (SIMPLIFIED)	BINARY VALUES	DIGIT REPRESENTED
	1 + 2 + 4	7
	2 + 4	6
	1 + 4	5
	4	4
	1 + 2	3
	2	2
	1	1
	None	0

TABLE 4-14. SIF CODER VOLTAGE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
4V1	+7.1	+6	+4.3	FIL	FIL	+250	-35	+0.23	FIL
4V2	+250	-4	0	FIL	FIL	0 to +0.2	-35	FIL	+250
4V3	+250	-35	0 to +0.2	FIL	FIL	0 to +0.2	-35	FIL	+250
4V4	+0.7	+3.1	FIL	FIL	+250	+90	+3.1	--	--
4V5	FIL	0	-15	+250	0	+250	-15	0	FIL
4V6	+0.1	+3.1	FIL	FIL	+250	+99	+3.1	--	--
4V7	0	+5.8	FIL	FIL	+142	+142	+5	--	--
4V8	+240	+142	+142	FIL	FIL	+250	-6.5	0	FIL
4V9	+1.15	+1.37	+1.15	FIL	FIL	FIL	+180	+115	+1.15
4V10	+250	+250	FIL	FIL	-30	-30	-16	--	--
4V11	+250	-15	+0.57	FIL	FIL	+0.57	-16	FIL	+250
4V12	+250	-16	+0.57	FIL	FIL	+0.57	-16	FIL	+250

NOTES: 1. Voltage measurements taken with unit removed and connected with service cable to main chassis.

2. Voltages taken with electronic multimeter.

A trigger signal from J1 is coupled to the grid of trigger amplifier 4V2A through coupling diode 4CR6 (figures 4-75 and 4-77). The amplified triggers from 4V2A are fed to blocking oscillator 4V3. The blocking oscillator output then drives the coder delay line assembly 4A1 consisting of delay line sections 4DL3, 4DL4, 4DL5, 4DL6, and 4DL7. Outputs at successive points along the coder delay line provide pulses at progressive time intervals (figure 4-78). Code number selection is accomplished by switching in the desired pulse outputs to trigger the code-train generator circuits.

When FUNCTION selector 4S1 is set to N (normal) the normal code number selection and generation functions are performed. The first pulse taken from the delay line is passed through coupling diode 4CR20. This start (framing or bracket) pulse will always be present regardless of the code number switch settings. The next six consecutive output pulses from the delay line are information pulses which are passed through switch diodes 4CR21 through 4CR26, inclusive (when switched on). The diode switching functions for these pulses are controlled by CODE number selector switch C (4S4B) and CODE number selector switch A (4S5A). The information pulses which have been selected are shown by indicator lamps 4DS1 through 4DS6, inclusive (figure 4-79). After the first six information pulses, the next pulse would be the X pulse (if used) which is passed through switch diode 4CR27. Indicator lamp 4DS7 will be lighted when the X pulse is selected.

TABLE 4-15. SIF CODER RESISTANCE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
4V1	115K	175K	1K	∞	∞	16K	100K	330	∞
4V2	14K	33K	0	∞	∞	14K	3.3K	180K	∞
4V3	14K	4.5K	40	∞	∞	∞	4.5K	∞	14K
4V4	7.5K	330	∞	∞	14K	9K	330	--	--
4V5	∞	270	2.6K	14K	0	14K	2.6K	180	∞
4V6	1.4K	330	∞	∞	14K	9K	330	--	--
4V7	3.3K	330	∞	∞	12K	10K	330	--	--
4V8	16K	10K	10K	∞	∞	14.5K	250K	0	∞
4V9	27	160	27	∞	∞	∞	19K	35K	27
4V10	14K	14K	∞	∞	400K	400K	1.5K	--	--
4V11	1.5K	1.5K	520	∞	∞	520	1.5K	∞	14K
4V12	14K	1.5K	520	∞	∞	520	1.5K	∞	14K

NOTES: 1. Resistance measurements taken to chassis ground with unit removed and disconnected.

2. All panel controls in ccw position.

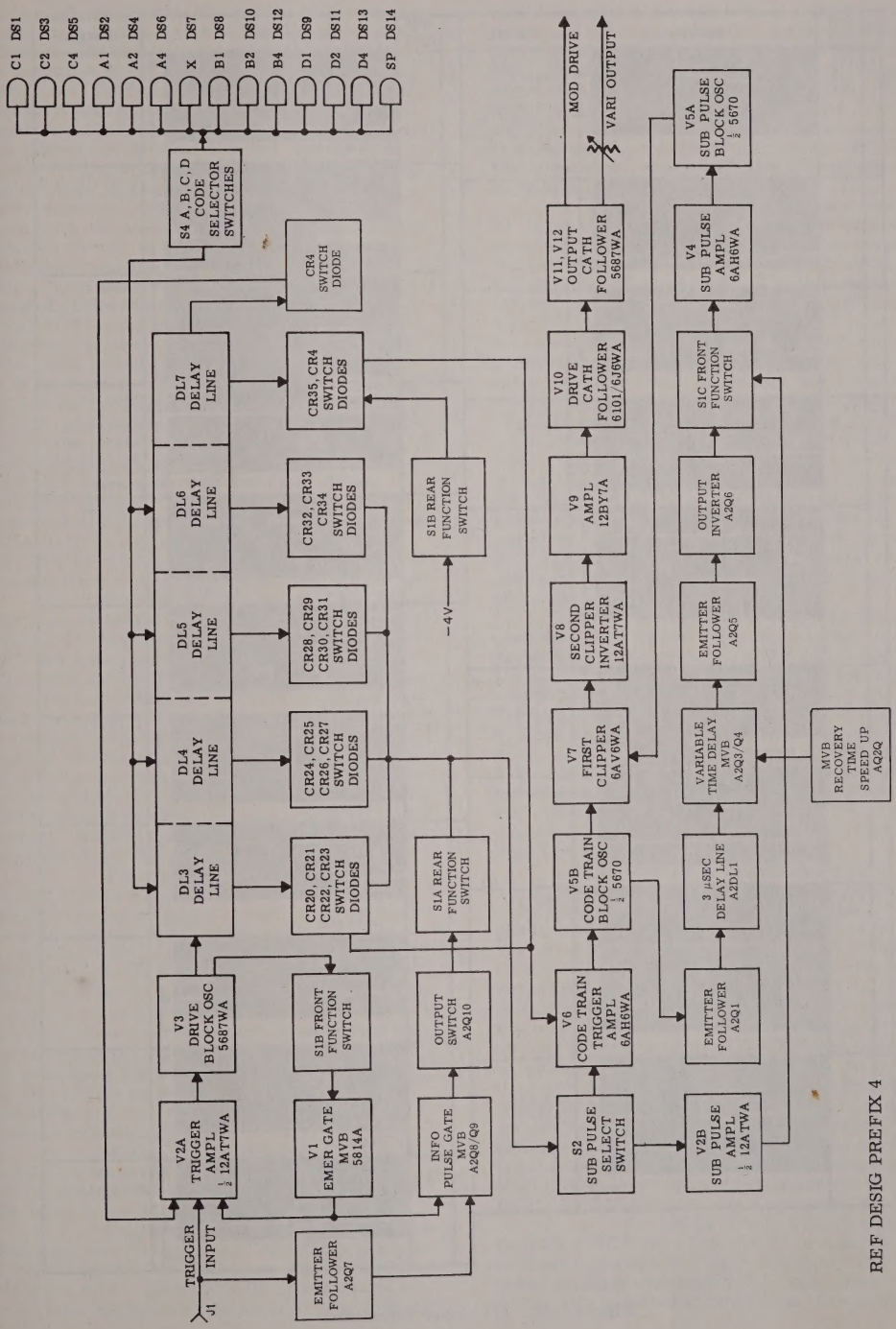


Figure 4-75. SIF Coder, Block Diagram

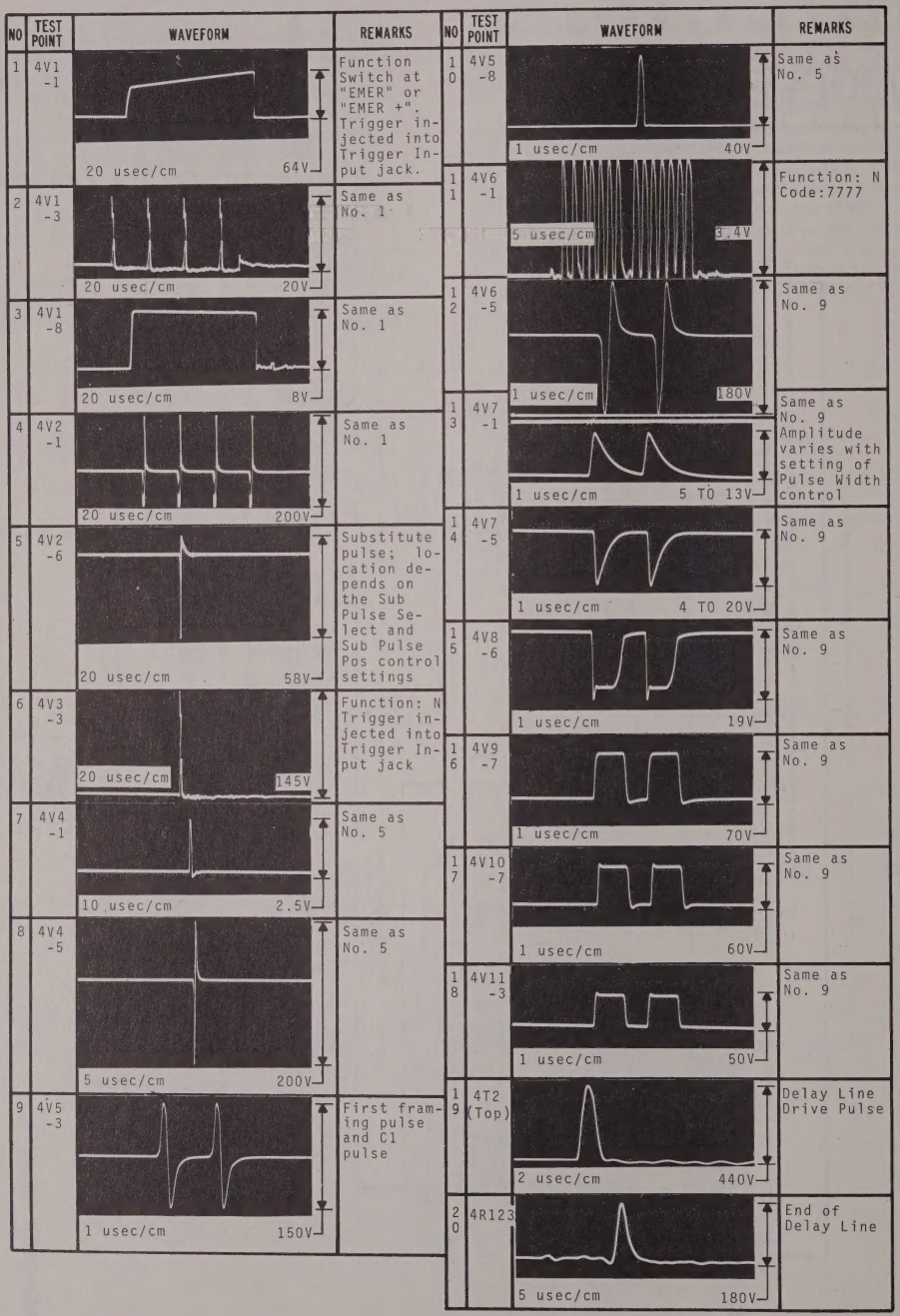


Figure 4-76. SIF Coder Waveforms

The next six consecutive information pulses are supplied through switch diodes 4CR28 through 4CR33, inclusive. The switching functions of these diodes are controlled by CODE number selector switch B(4S5B) and CODE number selector switch D (4S4A). The information pulses selected are shown by indicator lamps 4DS8 through 4DS13 inclusive. The next pulse taken from the delay line is a stop (second framing or bracket) pulse which is passed through coupling diode 4CR34. Since this framing pulse is always present regardless of the information pulses used, the associated indicator lamp 4DS14 is connected directly to the power source. The next pulse taken from the delay line is the emergency redrive pulse which is fed to a diode circuit consisting of diodes 4CR3 and 4CR4, and coupled through 4CR5 to the trigger amplifier 4V2A. The emergency redrive pulse plays no part in the information pulse coding, but is used to cause a repetition of the framing pulses for an emergency signal. This gate is inoperative during normal operation and does not pass the redrive pulse. The last pulse from the line would be the ID pulse (if used) which is supplied through switch diode 4CR35. This circuit is also disabled during normal operation. When FUNCTION selector 4S1 is set to ID (identification of position) switch diode 4CR35 is made conductive and the ID pulse output is passed through. When FUNCTION switch 4S1 is set to X, switch diode 4CR27 is made conductive and the X pulse is passed through.

When FUNCTION selector 4S1 (figure 4-80) is set to EMER (emergency), driver blocking oscillator 4V3 supplies a trigger pulse to the front half of emergency gate multivibrator 4V1 through the contacts of FUNCTION selector 4S1. The output of the first half of 4V1 is coupled to the second half through capacitor 4C3 and diode 4CR1 (figure 4-86). The function of capacitor 4C4 is to charge up when the prf of the trigger signal is excessively high (as it may be with emergency signals) placing a back bias on coupling diode 4CR1 and thus limiting the multivibrator action to a repetition rate of approximately 1000 pps. Clipper diode 4CR2 removes any negative spikes from the pulse.

The resulting gate pulse opens the gate circuit consisting of diodes 4CR3 and 4CR4. The gate remains open long enough for three redrive pulses (in addition to the normal trigger pulse) to pass through 4CR5 and 4C5 (figure 4-77) to the grid of trigger amplifier 4V2A. The initial trigger pulse and each of the following three redrive pulses permit the production of a pair of bracket pulses. The result is a series of four consecutive pairs of pulses for each input trigger pulse. The first pair of bracket pulses produced during EMER operation will contain whatever information pulses have been selected. The three pairs of pulses which follow, however, will contain no information pulses.

When FUNCTION selector 4S1 is set to EMER +X (emergency plus X), the emergency pulse train described above is obtained with the X pulse added to the information pulses.

Coupling diode 4CR20 and switch diode 4CR35 (figure 4-78) feed pulses directly to delay line 4DL2 at the input to the code train trigger amplifier 4V6 (figure 4-81). This delay line gives a fixed delay of 2 microseconds for the signal. Clipper diode 4CR14 removes any negative spikes. Other code pulses are fed to this point through the contacts of SUB PULSE SELECT switch 4S2. The output of delay line 4DL2 is passed through coupling diode 4CR37 to code train trigger amplifier 4V6. Further negative clipping is performed by diode 4CR13. The amplified trigger output from 4V6 drives code train blocking oscillator 4V5B which provides an output having the required pulse shape and amplitude characteristics.

When SUB PULSE SELECT switch 4S2 is set to the designation of any code pulse already selected (as shown by the indicator lamp), that particular code pulse is removed from the input of delay line 4DL2 and switched to coupling diode 4CR9 at the input to subpulse trigger amplifier 4V2B (figure 4-85). This removes the normal pulse from the code pulse train and substitutes a separately generated pulse which can be adjusted in time with respect to the normal pulse time. The output from coupling diode 4CR9 is amplified by sub pulse trigger amplifier 4V2B and then applied to delay line 4DL1 which provides up to 4 microseconds of adjustable delay. The output from delay line 4DL1 is coupled through diodes 4CR10 and 4CR8, passed through the contacts of 4S1 (in all but 1 position), and amplified by sub pulse trigger amplifier 4V4. The amplified trigger output from 4V4 drives the sub pulse blocking oscillator 4V5A which supplies a substitute pulse output having the required pulse shape and amplitude characteristics.

The output from code train blocking oscillator 4V5B (figure 4-81) and the output from sub pulse blocking oscillator 4V5A (figure 4-85) are applied to first clipper 4V7 (figure 4-82) through coupling diodes 4CR15 and 4CR12 respectively. The output from 4V5B is also routed to emitter follower 4A2Q1 for use in the interleave circuits (figure 4-88). PULSE WIDTH control 4R49 (figure 4-82) adjusts the width of the pulses in the code train for both signals. The pulse output from first clipper 4V7 is again clipped by second clipper 4V8, further clipped by clipper diode 4CR16, and then inverted by amplifier 4V9.

When LEVEL switch 4S3 is set to LO, the output from amplifier 4V9 is clipped by diode 4CR18, clipped again by diode 4CR19 (figure 4-83) and then applied to both sections of driver cathode follower 4V10. The output from 4V10 is sufficient to drive the output cathode follower stages using 4V11 and 4V12 in parallel. Tubes 4V11 and 4V12 deliver the required output power level at the MOD DRIVE and VARI OUTPUT connectors. Full output is available at the MOD DRIVE panel connector, while the low level VARI OUTPUT can be adjusted by means of the AMPLITUDE control.

When LEVEL switch 4S3 is set to HI, clipper diode 4CR18 is disconnected and the output cathode follower load impedance is increased. The increased output is thus obtained at some sacrifice in pulse shape (rise and decay time) characteristics. MOD DRIVE output approximately doubles while VARI OUTPUT increases by approximately one-third.

(b) CODE TRAIN DELAY LINE DRIVER CIRCUITS. - Figure 4-77 is a partial schematic diagram of trigger amplifier 4V2A and driver blocking oscillator 4V3. Under static conditions 4V3 is biased at cutoff from the -35 volt bias

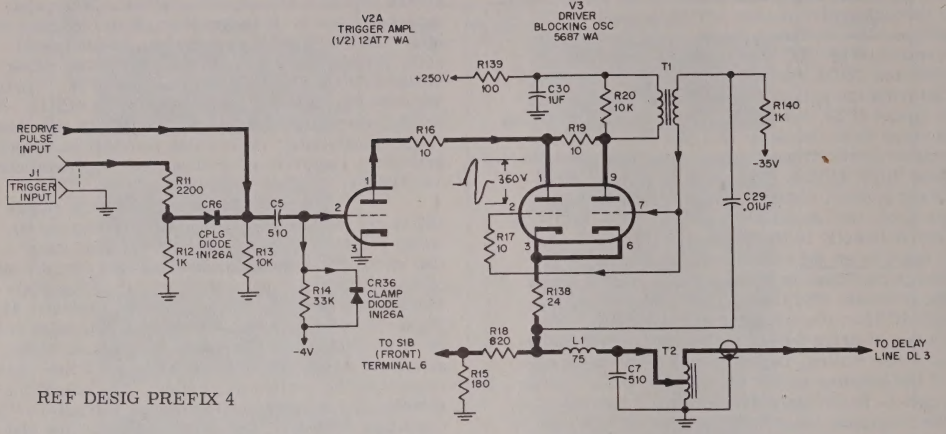


Figure 4-77. Trigger Amplifier and Driver Blocking Oscillator, Simplified Schematic Diagram

supply through the secondary of blocking oscillator transformer 4T1 and resistor 4R140.

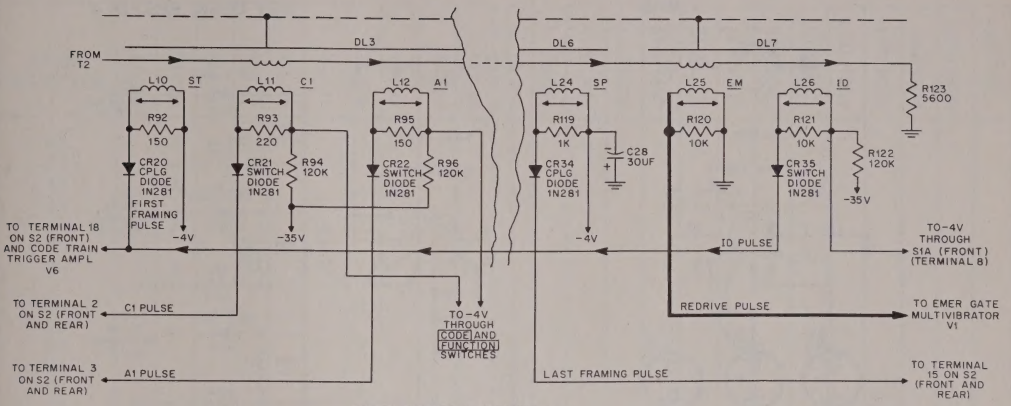
A positive trigger pulse is coupled to the grid of 4V2A through diode 4CR6 and capacitor 4C5. The amplified and inverted pulse output from 4V2A triggers blocking oscillator 4V3 into conduction. The signal path for this negative trigger pulse is through transformer 4T1 to the paralleled grids of 4V3. The pulse appearing at the grids of 4V3 is positive, and 4V3 is driven into conduction for a very short time, depending upon the characteristics of 4T1 and the time constant of the grid circuit, which is very low. This sudden sharp conduction of 4V3 produces a positive pulse at the cathode of 4V3, which is fed through 4L1 to the tap on 4T2. Since 4T2 functions as an autotransformer, the peak voltage at the top of 4T2 is approximately four times the peak voltage at the cathode of 4V3. A high voltage pulse of this amplitude is required to drive the code train delay lines.

Diode 4CR6 is connected in the circuit so that only positive pulses will pass to the grid of 4V2A. Resistors 4R16, 4R17, and 4R19 are inserted between the paralleled plates and grids of tubes 4V2A and 4V3 for the purpose of suppressing parasitic oscillations. Coil 4L1, capacitor 4C7, and autotransformer 4T2 have a resonance characteristic which aids in shaping and peaking the output waveform of this circuit. When the FUNCTION selector is in the EMER (emergency) or EMER +X position, a portion of the positive pulse at the junction of the cathode resistors 4R18 and 4R15 is applied to emergency gate multivibrator 4V1 in order to initiate operation of the emergency circuits.

(c) CODE TRAIN DELAY LINES. - Figure 4-78 is a simplified schematic diagram of the delay lines and associated circuitry used to generate the SIF code train. Refer to the overall schematic diagram of the SIF Coder (figure 5-63) for the complete circuitry. Under static conditions, the anodes of the switching diodes are biased at either -4 volts or -35 volts. The high-amplitude positive pulse from autotransformer 4T2 is fed to cascaded delay lines 4DL3 through 4DL7. Pick-off coils 4L10 through 4L26 are located within the magnetic fields of these delay lines. The time delay of the voltage induced in an individual pick-off coil is dependent upon its location with respect to the input end of the cascaded delay lines. In the absence of a drive pulse from 4T2, there will be no output pulse occurring at any of the coupling and switching diodes, 4CR20 through 4CR35.

When a -35 volt bias is applied to the anode of one of the switching diodes, the pulse induced in the pick-off coil is not of sufficient amplitude to pass through the associated diode. However, the pulse is of sufficient amplitude to overcome a a bias of only -4 volts. Individual code pulses are selected in the following manner: normally, -35 volt bias is applied to the 4CR21 anode (to use the C1 diode as an example) through 4R94 and pick-off coil 4L11. The output at the cathode of this diode will then be zero even though a pulse is induced into pick-off coil 4L11. However, if the -4 volt bias is connected to the junction of 4R94 and 4L11 through the CODE and FUNCTION selectors, the positive pulse from 4L11 will overcome the -4 volt bias, and the positive C1 pulse will pass through 4CR21 to SUB PULSE SELECT switch 4S2.

Note that pick-off coils 4L10 (for start pulse) and 4L24 (for stop pulse) are permanently connected to the -4 volt bias, and there is no provision for the application of -35 volt bias. This means that these coils will pass the bracket pulses through their coupling diodes, 4CR20 and 4CR34, whenever a drive pulse is applied to the input of the code train delay



REF DESIG PREFIX 4

Figure 4-78. Code Train Delay Lines, Simplified Schematic Diagram

lines. The redrive pulse from 4L25 (occurring after the stop pulse) is passed directly to trigger diode 4CR4 gate circuit at the output of emergency gate multivibrator 4V1.

The pick-off coils, 4L10 through 4L26, are each physically adjustable so that they may be set at a precise position with respect to the start of the delay lines. Resistors 4R94, 4R96, and the other delay line resistors having similar functions in this circuit prevent the -4 volt bias supply from loading the -35 volt supply when the -4 volt bias is switched to the switching diodes. Resistor 4R123 terminates the delay line in its characteristic impedance, thus preventing pulse reflection in the line.

(d) CODE SELECTOR SWITCH CIRCUIT ANALYSIS. - Figure 4-79 is a simplified schematic diagram of several of the CODE number selectors in the SIF Coder. The function of the switches illustrated in figure 4-79 is typical of the others in this unit. (Refer to the overall schematic diagram of the SIF Coder, figure 5-63.) As mentioned previously, the code train switching diodes (which can be turned off or on), are biased with a -35 volt potential when off. In this condition, a positive pulse from a pick-off coil is not of sufficient amplitude to allow the pulse to pass through the diode. However, when this -35 volt bias is raised to -4 volts, the positive pulse from the pick-off coil will overcome this bias and the pulse will pass through the diode. The purpose of CODE selector section 4S4BB is to replace the -35 volt bias with a -4 volt bias. The use of -4 volt bias for the "on" state rather than zero prevents the passage of spurious low level pulses.

CODE selector 4S4 is shown in position 0, therefore none of the diodes are "turned on" by the application of the -4 volt bias. When the selector is turned to position 1, -4 volts is applied to diode 4CR21 through terminals 6 and 9 of 4S4BB (front). When the selector is turned to position 2, diode 4CR23 is "turned on" through terminals 5 and 9 of 4S4BB (front). When the selector is turned to position 3, diodes 4CR21 and 4CR23 are both turned on through terminals 4, 8, and 9 of 4S4BB (front). Setting the selector to position 4, 5, 6, or 7 turns on the correct diodes to produce SIF code pulses representing numerals 4, 5, 6, or 7 in the "C" grouping of the SIF code system. The -4 volt bias is supplied to 4S4 from output switch 4A2Q10. During normal operation this bias remains at -4 volts; in emergency signal production, however, the bias will change to -35 volts during the emergency pulse train, eliminating information pulses from the three pairs of "bracket" pulses following the normal train.

CODE selector section 4S4BA turns on neon lamps 4DS1, 4DS3, and 4DS5, the "C1", "C2", and "C4" lamps, respectively. The sum of the values of the lamps which are on corresponds to the SIF coded number selected. For example, when lamps 4DS1 (C1) and 4DS3 (C2) are on, the number indicated for the C group is 3. When 4DS3 (C2) and 4DS5 (C4) are on, the number indicated is 6. The lamps are turned on by grounding one of their terminals through the contacts of CODE selector 4S4B.

The neon CODE lamps, 4DS1 through 4DS14 (shown in the overall schematic diagram, figure 5-63) are type NE-2 lamps which light at approximately 90 volts dc. Resistors 4R124, 4R125, and 4R126, and the other resistors with a similar function, are used for limiting current through the neon lamps since they are powered from the regulated 150 volt power supply. Resistors 4R93, 4R95, and 4R97, and the other resistors with a similar function, located across the pick-off coils in the delay line assembly (figure 4-78) are used to limit the voltage across their respective coils. Notice that the first pick-off coil is loaded with 150 ohm resistor 4R92. The next coil, 4L11 is locaded with 220 ohm resistor 4R93, 4R93, and 4L12 is loaded with 150 ohm resistor 4R95.

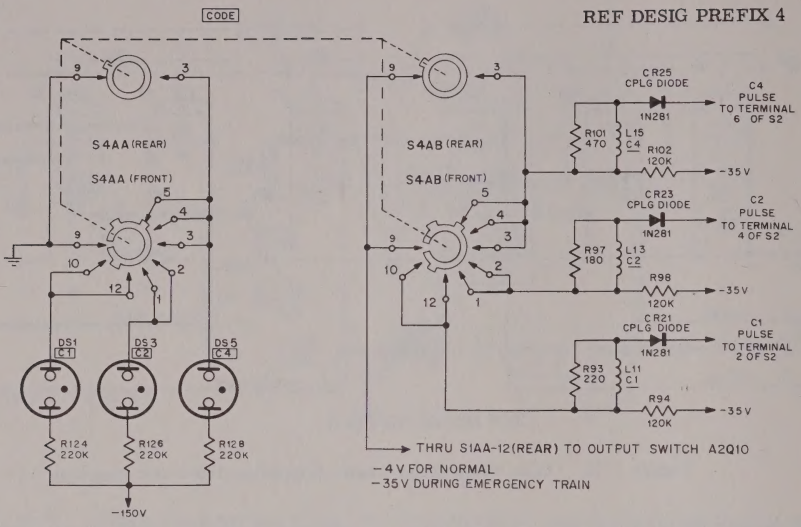


Figure 4-79. Code Number Selector, Simplified Schematic Diagram

Table 4-16 indicates which code train switching diodes (and associated indicator lamps) are "turned on" by the four CODE selectors. For example, suppose that code number 1234 is chosen by setting the CODE selectors to "1234". The switch diodes turned on would be: 4CR22, 4CR30, 4CR21, 4CR23, and 4CR33. The lamps which are lit would be: 4DS2, 4DS10, 4DS1, 4DS3, and 4DS13. Refer to the schematic diagram of the SIF Coder for identification of all the switching diodes and neon lamps.

(e) FUNCTION SELECTOR CIRCUIT ANALYSIS. - Figure 4-80 is a simplified schematic diagram of the circuits associated with FUNCTION selector 4S1. The purpose of this three-section switch is to switch the ground connection for the neon code lamps, to apply the -4 volt bias for "turning on" the code train delay line switching diodes, to apply the -4 volt bias for "turning on" the "X" pulse and ID pulse switching diodes, and to apply a trigger pulse to the emergency gate multivibrator.

The FUNCTION selector provides the following circuit connections:

1. N (Normal) Position - 4 volt, -35 volt, and ground connections are not altered, so normal code pulse production is permitted. The sub pulse line from SUB PULSE SELECT switch 4S2 is connected to sub pulse amplifier 4V2B, permitting pulse substitution if desired.

2. ID Position - This is the same as the N position with one exception: A -4 volt bias replaces the -35 volt bias applied to ID pulse switching diode 4CR35 causing the ID pulse to appear after the code pulse train.

3. X Position - This is the same as the N position with the following exceptions: A -4 volt bias replaces the -35 volt bias applied to X pulse switching diode 4CR27, causing the X pulse to appear in the middle of the code pulse train, and a ground is applied to "X" pulse neon lamp 4DS7.

4. EMER +X Position - This is the same as the X position with one exception: A trigger pulse is fed to emergency gate multivibrator 4V1 through 4S1 (front), causing the bracket pulses to be repeated three times following the main code pulse train.

5. EMER Position - This is same as the EMER +X position, except that the -4 volt bias and ground are not applied to the X pulse switching diode 4CR27 (and X pulse lamp 4DS7) so the X pulse is removed from the code train.

6. I Position - In this position, functions are the same as for the N position, except that the output of code train blocking oscillator 4V5B is also fed to emitter follower 4A2Q1 in the interleave circuit. The resulting interleave pulse train is passed through contacts 1 and 7 of 4S1C, front, and fed to sub pulse trigger amplifier 4V4. The substitute pulse circuits do not perform their normal function in this position. The repeated (interleaved) code train produced can be adjusted in position by means of the INTERLEAVE control.

(f) CODE TRAIN CIRCUITS.

1. CODE TRAIN TRIGGER AMPLIFIER 4V6 AND CODE TRAIN BLOCKING OSCILLATOR 4V5B. - Figure 4-81 is a simplified schematic diagram of the first two stages of the code train circuit. In the absence of pulses from the code train delay line, code train blocking oscillator 4V5B is cut off by approximately -18 volts of bias from a voltage divider consisting of resistors 4R26 and 4R30.

Incoming code pulses are fed to the

Table 4-16. Code Number Selector Chart

CODE SELECTOR	4CR21	4CR22	4CR23	4CR24	4CR25	4CR26	4CR28	4CR29	4CR30	4CR31	4CR32	4CR33	4DS1(C1)	4DS3(C2)	4DS5(C4)	4DS2(A1)	4DS4(A2)	4DS6(A4)	4DS8(B1)	4DS10(B2)	4DS12(B4)	4DS9(D1)	4DS11(D2)	4DS13(D4)
A1		X														X								
A2				X													X							
A3		X		X												X	X							
A4						X												X						
A5		X				X										X		X						
A6				X		X											X	X						
A7		X		X		X										X	X	X						
B1							X												X					
B2									X											X				
B3							X		X										X	X				
B4											X										X			
B5							X				X								X		X			
B6									X		X									X	X			
B7							X		X		X								X	X	X			
C1	X												X											
C2			X											X										
C3	X		X										X	X										
C4					X										X									
C5	X				X								X		X									
C6			X		X									X	X									
C7	X		X		X								X	X	X									
D1								X														X		
D2										X													X	
D3								X		X												X	X	
D4												X												X
D5								X				X										X		X
D6										X		X											X	X
D7								X		X		X										X	X	X

NOTE

Diode 4CR27 switches "X" pulse, 4CR34 couples SP (last framing pulse), and 4CR35 switches "ID" pulse. Neon lamps 4DS7 ("X") and 4DS14 (SP) not shown above for clarity. Refer to schematic diagram of SIF Coder unit.

grid of 4V6 which has a voltage gain of approximately 50. The amplified and inverted pulses from the plate of 4V6 are coupled to the grid of 4V5B through blocking oscillator transformer 4T5. Tube 4V5B conducts for less than one microsecond. As a result of this heavy surge of plate current, sharp positive pulses, one for each code train pulse, are generated at the cathode of 4V5B. At the conclusion of each pulse, 4V5B returns to the cutoff condition, awaiting the next positive pulse to appear at its grid.

Clipper diodes 4CR13 and 4CR14 bypass negative portions of the code train pulses coming from 4CR20, 4CR35, and 4S2. Delay line 4DL2 causes a two-microsecond delay of the code train pulses before they appear at the grid of 4V6. This is done to provide a two microsecond reference for substitute pulse generation. Fixed cathode bias on 4V6 is provided by the voltage divider consisting of 4R39, 4R40, and 4R41. The screen voltage of 4V6 is also held essentially constant by this voltage divider. Capacitor 4C16 bypasses the cathode of 4V6, and effectively holds the cathode at ground for ac. The cathode bias for 4V6 is common with the cathode of sub pulse trigger amplifier 4V4, since 4R41 is the cathode resistor for both stages. Resistor 4R46 in the grid circuit of 4V5B limits the grid current of this tube. The positive output pulses at the junction of 4R43 and 4R44 are fed through coupling diode 4CR15 through Width Adj 4R47, and capacitor 4C20 to first clipper 4V7 (figure 4-82). Diode 4CR15 prevents positive pulses from passing back to the cathode circuit of 4V5B.

2. FIRST CLIPPER 4V7, SECOND CLIPPER-INVERTER 4V8, AND AMPLIFIER 4V9. - The next four stages discussed in the code train circuits are shown in figure 4-82. First clipper 4V7 is biased by a voltage divider consisting of resistors 4R52 and 4R53 to provide peak clipping of the incoming code pulses. In addition, a voltage amplification of approximately four times is accomplished. The cathode bias for second clipper 4V8A is the same

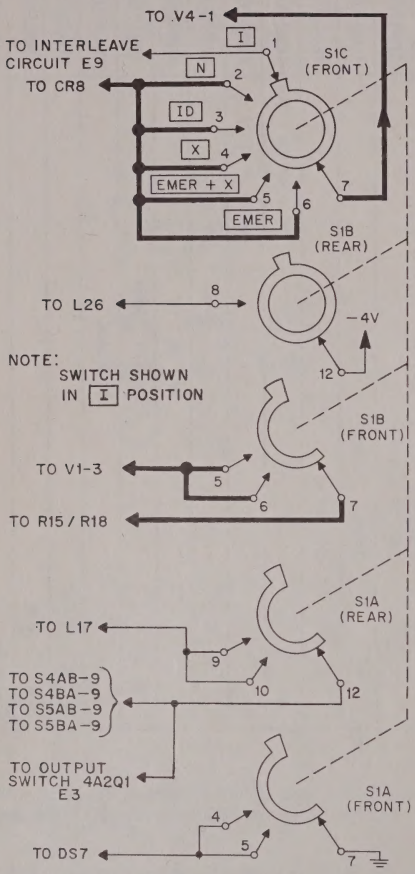


Figure 4-80. Function Selector Connection, Simplified Schematic Diagram

as the screen voltage for the preceding tube, 4V7, and the control grid of 4V8A is coupled to the plate of 4V7. This arrangement places a substantial positive bias on the cathode with respect to the grid voltage, and results in negative peak clipping. Inverter 4V8B is operated with approximately 6.4 volts of fixed bias derived from the junction of a voltage divider consisting of resistors 4R60 and 4R62. This stage inverts and amplifies the positive code pulses appearing at control grid pin 7. The voltage gain of this stage is approximately four.

Amplifier 4V9 functions as a video amplifier, providing a voltage gain of approximately two and half times. When the LEVEL switch is in the LO position, clipper diode 4CR18 is in parallel with resistors 4R64 and 4R65 and peaking coil 4L7.

Negative clipping provided by diode 4CR18 results in excellent square pulse waveform at some sacrifice in gain. When the LEVEL switch is placed in the HI position, however, clipper diode 4CR18 is disconnected. The absence of clipping increases the stage output approximately 50 percent, at some sacrifice in pulse squareness.

3. DRIVER CATHODE FOLLOWER 4V10 AND OUTPUT CATHODE FOLLOWER 4V11/4V12. - Figure 4-83 is a simplified schematic diagram of driver cathode follower 4V10 and output cathode follower 4V11/4V12. The purpose of these stages is to provide the necessary power and adequate isolation between the preceding code train circuits and the load, and also to present the output at a suitable impedance to match the load circuits. Two parallel-connected tubes (each consisting of two triode sections also connected in parallel) are used to provide sufficient power at the output to drive the external circuits using these code pulses for a source of modulating signal.

The positive output pulses from 4V9 are passed on through coupling capacitor 4C26 to negative peak clipper 4CR19 and to driver cathode follower 4V10. Any significant undershoot which might occur at this point is removed by clipper diode 4CR19. The cathode load circuit of 4V10 contains a peaking coil 4L9 which improves high frequency response. Direct-coupled input to the paralleled grids of the cathode follower stage is used.

Two output connectors are provided on the front panel of the SIF Coder. VARI OUTPUT connector 4J3 provides an output for examination and utilization of the code pulses. The output signal level at this point is adjustable from zero to maximum by means of AMPLITUDE control 4R91. The MOD DRIVE connector 4J2 provides an output connection to the pulse modulator circuits of a UHF oscillator. The LEVEL switch shorts out one of the cathode load resistors when in the LO position, and permits resistor 4R89 to be part of the cathode load circuit when it is in the HI position. The unloaded output voltage at the VARI OUTPUT connector is continuously variable from zero to approximately 20 volts when the LEVEL switch is set to LO, and from zero to approximately 30 volts when the LEVEL switch is set to HI. The unloaded output at the MOD DRIVE connector is approximately 40 volts when the LEVEL switch is set to LO, and approximately 80 volts when the LEVEL switch is set to HI.

(g) SUBSTITUTE PULSE CIRCUITS

1. SUB PULSE SELECT SWITCH 4S2. - SUB PULSE SELECT switch 4S2 permits the operator to eliminate one of the code pulses from the code train and substitute a pulse which can be adjusted ±1.6 microseconds in position with respect to the normal position. Figure 4-84 is a simplified schematic diagram of the SUB PULSE SELECT switch circuits. The pulse from 4CR20 (first framing pulse), and the pulse from 4CR35 (ID pulse)

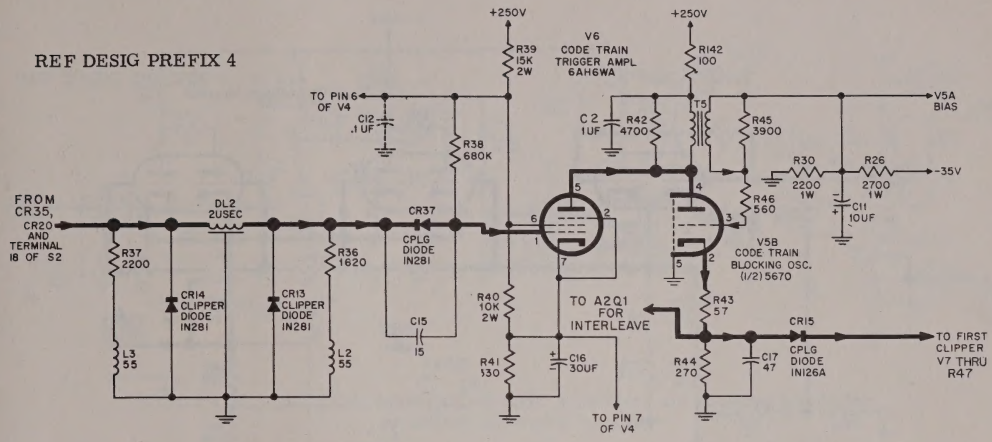


Figure 4-81. Code Train Trigger Amplifier and Blocking Oscillator, Simplified Schematic Diagram

are fed directly to code train trigger amplifier 4V6 so that no substitution can be made. All other substitute pulses are subject to selection by the SUB PULSE SELECT switch. This switch is shown in the OFF position, consequently no pulse is being eliminated and none being fed to sub pulse amplifier 4V2B. However, when the switch is set to any active code pulse position, that particular pulse is not fed to code train trigger amplifier 4V6, but is fed to sub pulse amplifier 4V2B. No substitute pulse is produced when the SUB PULSE SELECT switch is set to an inactive code pulse position. When using the interleaved train function, 4S2 must be left in the OFF position, otherwise a pulse will be removed from both the normal and the delayed pulse train but no variable pulse will be substituted.

2. SUB PULSE AMPLIFIER 4V2B, SUB PULSE TRIGGER AMPLIFIER 4V4, AND SUB PULSE BLOCKING OSCILLATOR 4V5A. - Figure 4-85 is a simplified schematic diagram of the substitute pulse circuits. Sub pulse amplifier 4V2B is cathode biased. This stage amplifies and inverts the pulse arriving from SUB PULSE SELECT switch 4S2. Sub pulse trigger amplifier 4V4 is a high-gain pentode tube which amplifies the pulse from 4V2B. Cathode bias for 4V4 is provided by the same cathode resistor used by code train trigger amplifier 4V6. Since the average cathode bias

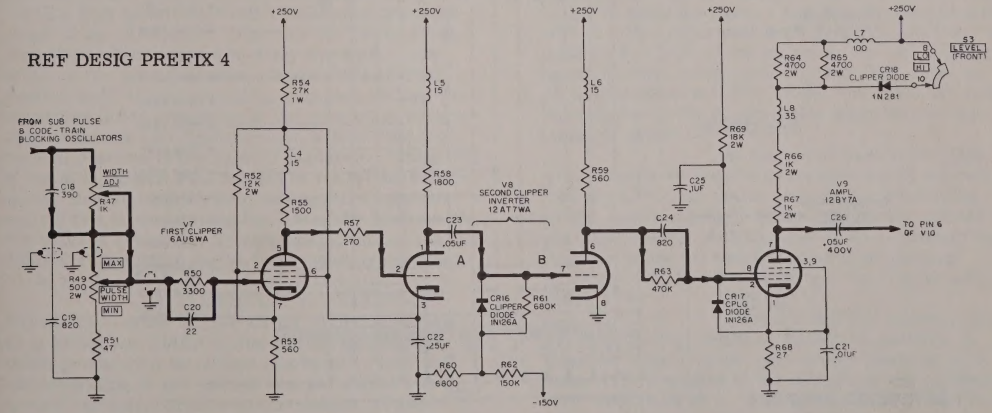


Figure 4-82. 1st Clipper, 2nd Clipper-Inverter, and Amplifier, Simplified Schematic Diagram

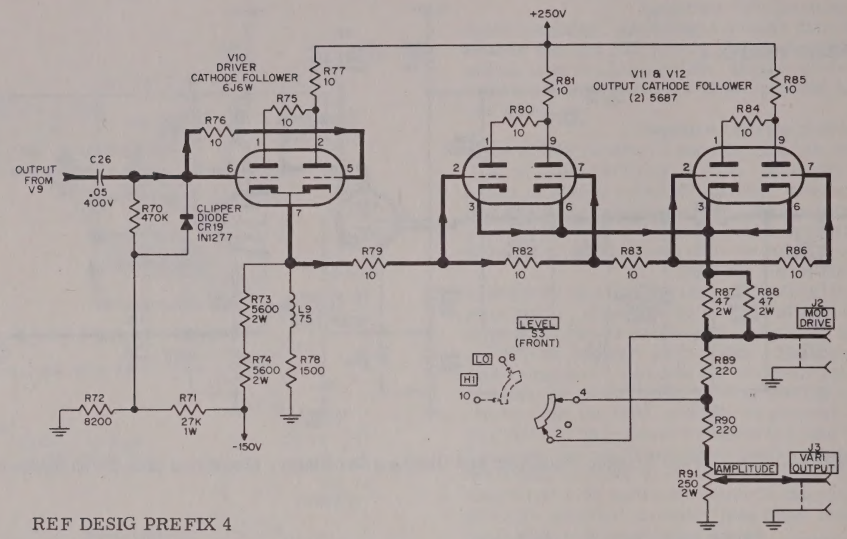


Figure 4-83. Driver and Output Cathode Followers, Simplified Schematic Diagram

voltage across this common cathode resistor 4R41 is not only a function of the current from ground through 4R41, 4R40, and 4R39, but is also a function of the duty cycle of the signal (determined by the total number of pulses in the code train). The bias of both stages (4V6 and 4V4), is automatically adjusted to the same level. This has the effect of providing essentially constant and similar output amplitudes from both the normal code train circuit and the substitute pulse circuit.

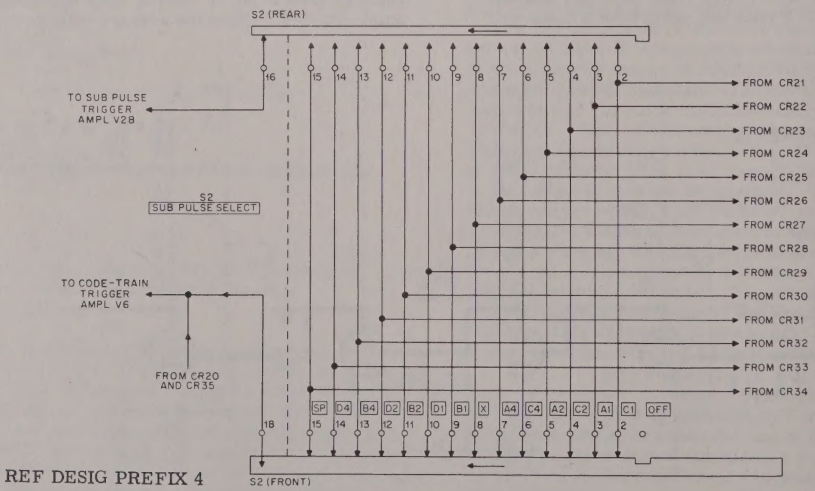


Figure 4-84. Sub Pulse Select Switch, Simplified Schematic Diagram

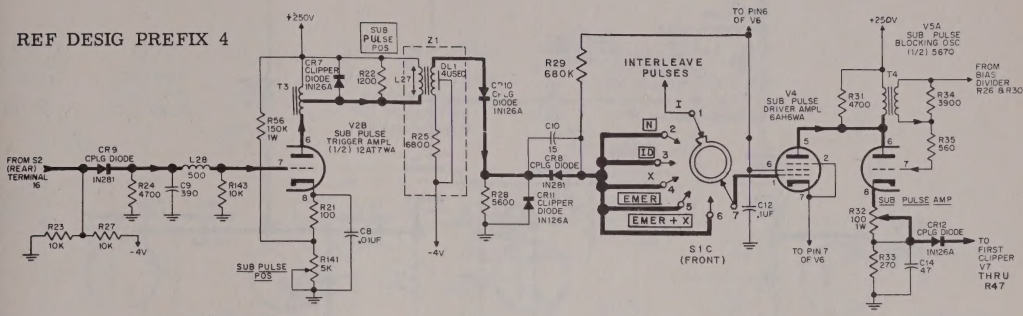


Figure 4-85. Sub Pulse Amplifier, Trigger Amplifier, and Blocking Oscillator, Simplified Schematic Diagram

Sub pulse blocking oscillator 4V5A is biased beyond cut off by approximately -20 volts of bias. This stage remains idle until triggered by the sub pulse trigger amplifier, at which time it goes through one cycle of operation to produce a single pulse at its cathode circuit. This stage then remains cut off until triggered again.

Coupling diode 4CR9 will pass positive pulses from the SUB PULSE SELECT switch to the grid of 4V2B but will block undesired negative undershoots. The plate circuit of 4V2B contains an auto-transformer 4T3 which is coupled to delay line 4DL1 by coil 4L27. Coil 4L27 and 4DL1 form a transformer for feeding the output pulse into the grid circuit of sub pulse trigger amplifier (through the contacts of 4S2). Coil 4L27 is adjustable in position along 4DL1, providing a means of setting the time delay of the pulse to 4V4 from approximately zero to approximately four microseconds. This coil adjustment is the SUB PULSE POS (position) control located on the front panel of the SIF Coder. Figure 4-81 shows delay line 4DL2 which is used to delay the entire code train by two microseconds. If SUB PULSE POS control 4L27 is adjusted for a minimum delay; the substitute pulse appearing in the code train occurs approximately two microseconds sooner than the normal position of the pulse it replaces. Similarly, if the SUB PULSE POS control is set for maximum delay, then the substitute pulse appears approximately two microseconds later than the position of the pulse it replaces. The nominal limits of the SUB PULSE POS control on the front panel are marked -1.5, -1.0, -.5, 0, and +.5, +1.0 and +1.5.

(h) EMERGENCY CODE TRAIN CIRCUITS. - When the SIF Coder Function selector is in either the EMER or the EMER +X position, the coder produces a simulated emergency reply signal consisting of one pair of bracket pulses containing the selected information pulses, followed by three empty pairs of "bracket" pulses. This is accomplished by means of the emergency gate multivibrator 4V1 (figure 4-86) which permits the passage of a total of four "bracket" pulse pairs, and by the information pulse gating multivibrator 4A2Q8/Q9 which permits the coded information pulses to be inserted into the first pair of brackets but gates them out of the three pairs which follow.

1. EMERGENCY GATE MULTIVIBRATOR 4V1. -The purpose of emergency gate multivibrator 4V1, shown in figure 4-86, is to allow one input trigger pulse to the SIF coder to produce four consecutive sets of bracket-type pulses. This is accomplished by generating a rectangular gate pulse which will allow three additional consecutive redrive pulses (from the 4L25 pick-off coil on the code train delay line) to serve as trigger pulses for the code train delay line driver circuits after the normal trigger pulse actuation. Emergency gate multivibrator 4V1 is a monostable multivibrator which, in its quiescent state, has one section (section "A", pins 1, 2, and 3) conducting heavily due to the positive bias on the control grid. This bias is provided by voltage dropping resistors 4R1 and 4R2 and Emergency Code Adjust potentiometer 4R147. The right hand section of 4V1 (section "B" pins 6, 7, and 8) is cut off due to the -35 volt bias applied to its control grid through 4R9. Also at this time, diodes 4CR3, 4CR4, and 4CR5 are conducting due to the positive bias supplied through resistor 4R10.

At the end of each code pulse train a positive redrive pulse appears at the cathode of 4CR4, and passes through the conducting diode, but is normally short-circuited to ground through resistor 4R5 because 4CR3 is conducting. This prevents the redrive pulse from passing through 4CR5 to act as a trigger for trigger amplifier 4V2A.

When FUNCTION selector 4S1 is placed in the EMER or EMER +X position, a positive trigger pulse from driver blocking oscillator 4V3 is applied to the cathode of the conducting "A" section of 4V1. This cuts off 4V1A, and the plate of 4V1A produces a positive pulse which is fed through 4C3 and coupling diode 4CR1 to the grid of 4V1B, causing this section of the tube to conduct. When this occurs, a positive rectangular pulse

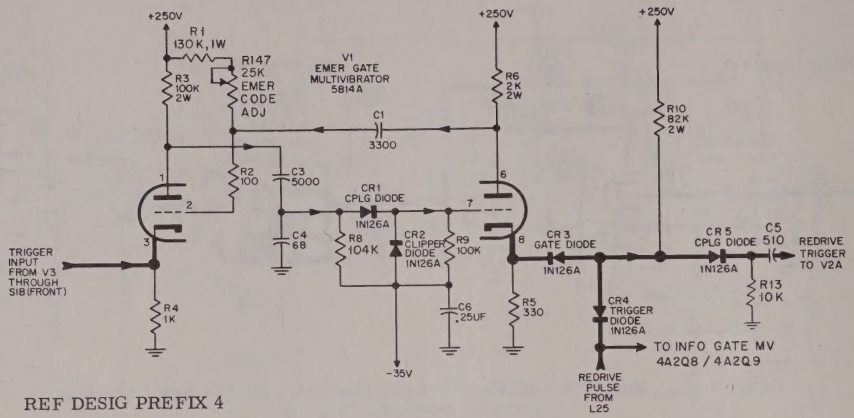


Figure 4-86. Emergency Gate Multivibrator, Simplified Schematic Diagram

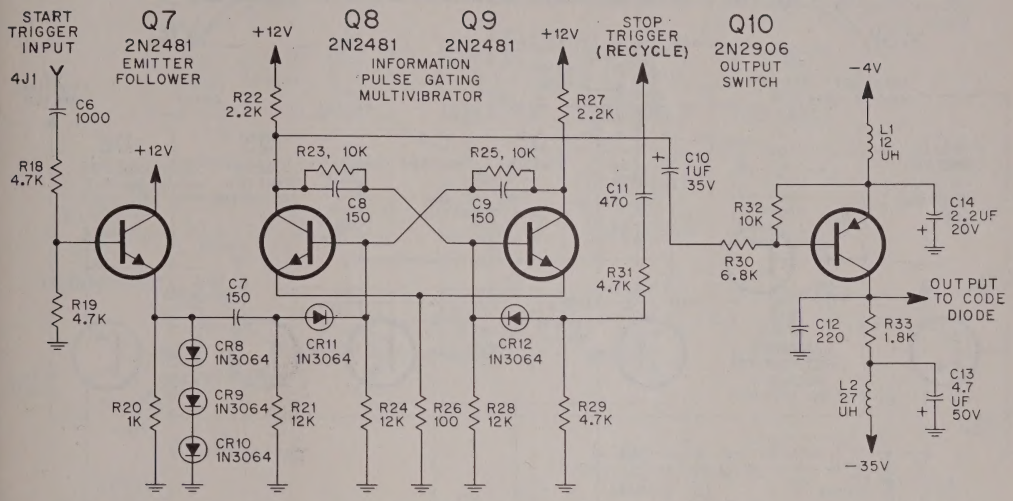
appears at the cathode of 4V1B, diode 4CR3 is cut off, and the redrive pulses are not shorted out but are allowed to pass on through 4CR4 and 4CR5 to trigger amplifier 4V2A.

The time constants of the emergency gate multivibrator circuit are such that the width of the gate pulse generated is between approximately 70 and 90 microseconds. Since each SIF code pulse train is approximately 20 to 25 microseconds long, the width of the gate pulse is sufficient to allow three, but no more than three, consecutive redrive pulses to substitute as trigger pulses for the code train delay line driver circuits. When the gate pulse comes to an end, the SIF Coder remains inactive until it is again activated by an external trigger pulse. When the prf of the trigger input to 4V1 is excessive, capacitor 4C4 charges up, reverse-biasing 4CR1, and limiting the multivibrator action to approximately 1000 pps.

2. INFORMATION PULSE GATING MULTIVIBRATOR. - Information pulse gating multivibrator 4A2Q8/Q9 (located on the Interleaved Code Train Generator Subassembly A2) produces a gate pulse which, when applied to the code train diodes, allows the information pulses to be placed in the first pair of bracket pulses and then blocks them so that they do not appear in the second, third, or fourth pair of pulses in the emergency train. Gating action is started by the trigger pulse from TRIGGER INPUT connector 4J1 (figure 4-87). This trigger pulse is fed through emitter follower 4A2Q7 and then limited to approximately 2 volts by the series string of diodes 4A2CR8, 4A2CR9, and 4A2CR10. The positive pulse is passed through diode 4A2CR11 to the base of 4A2Q8 in the bistable multivibrator. The multivibrator changes conductive states, producing the leading edge of a negative pulse at the collector of 4A2Q8. The trailing edge of this gate pulse is formed at the 4A2Q8 collector when the redrive pulse (also used to initiate a second pair of "bracket" pulses) is applied to 4A2Q9, causing the multivibrator to return to its original state. The output pulse from the 4A2Q8 collector is coupled through 4A2C10 and 4A2R30 to output switch 4A2Q10. This stage is normally nonconducting and so its emitter voltage, which is applied to the code train switching diodes, is -35 volts, which back-biases the diodes into non-conduction. When the gate pulse is applied to the base of 4A2Q10, however, it conducts and the emitter voltage rises to -4 volts. This voltage applied to the switching diodes permits diodes to conduct when a code pulse is also present.

(i) INTERLEAVED CODE OUTPUT CIRCUITS. - The SIF Coder can produce an output signal which contains a normal pulse train in combination with a second train slightly delayed from and interleaved with the first. This is accomplished by the circuits on Interleaved Code Train Generator Subassembly 4A2.

The normal SIF code train signal is picked up from the code train blocking oscillator 4V5B cathode resistors 4R43 and 4R44 (figure 4-81) and is fed to emitter follower 4A2Q1 (figure 4-88). The output from the 4A2Q1 emitter is limited to approximately two volts by the series string of diodes 4A2CR1, 4A2CR2, and 4A2CR3. A fixed delay of 0.3 microsecond is introduced by delay line 4A2DL1. The output of 4A2DL1 is coupled through 4A2C2 and diode 4A2CR5 to the variable time delay multivibrator 4A2Q3/Q4. The duration of the "on" time of 4A2Q3/Q4 is controlled by the time constant of capacitor 4A2C3 and resistors 4A2R9 and 4A2R8. This time constant is controlled by varying the INTERLEAVE control 4R148, in parallel with 4A2R8. This network is connected to +12 volts provided by a separate power supply on the 4A2 subassembly. The recovery time for the multivibrator is shortened by multivibrator recovery time speedup stage 4A2Q2, which supplies a low resistance discharge path for capacitor 4A2C3 during the switchback period. The output from 4A2Q4 is fed to the



PREFIX INCOMPLETE REFERENCE DESIGNATIONS WITH 4A2.

Figure 4-87. Information Pulse Gating Circuit, Simplified Schematic Diagram

isolating emitter follower 4A2Q5, from which it is applied to the differentiating network consisting of resistor 4A2R15 and capacitor 4A2C5. Diode 4A2CR7 passes only the negative-going trailing edge of the differentiated pulse (delayed by the length of the pulse) on to the output inverter 4A2Q6. The positive output signal from 4A2Q6 collector, consisting of a trigger for each pulse of the code train, is connected to the FUNCTION selector contacts, from where it is routed (when the selector is in the I position) to sub pulse trigger amplifier 4V4 (figure 4-85). The trigger pulses actuate the sub pulse blocking oscillator 4V5A in the same manner as normal substitute pulse triggers, and the "interleave" pulses are processed from here on in the same manner as the substitute pulses.

(5) TS-1253A PANEL-CHASSIS ASSEMBLY.- The circuit functions of the panel-chassis assembly are shown in the block diagram in figure 4-89 and are described below. Voltage readings are given in table 4-17 and resistance readings in table 4-18. Further details on power distribution in the assembly may be found in figure 5-59.

The ac power input (at 5J1 pins E and F) is automatically turned off in the event that an excessively high temperature causes thermostatic switch 5S1 to open (figure 5-59). Thermostatic switch 5S1 will close, restoring the input power, when temperatures within the equipment return to normal. The ac power to associated equipment (at 5J1 pins C and D) is also turned off by operation of the thermostatic switch 5S1. Removal of the panel-chassis assembly from its electrical equipment case causes interlock switch 5S2 to open, removing power from the TS-1253A unit. However, this interlock does not interrupt the ac power fed to associated equipment (at 5J1 pins C and D). Power is applied to the TS-1253A circuits through POWER switch 5S3. Line fuses 5F1 and 5F2 provide primary power overload protection, with neon bulbs 5DS2 and 5DS3 serving as blown fuse indicators. Primary power is applied to power transformer 5T1 through a series of interlock jumpers in each of the four plug-in units. The secondary windings of transformer 5T1 supply ac power to all rectifier and heater circuits in the TS-1253A. Power to the equipment case blower is fed out (from a point after the fuses) through thermostatic switch 5S4 and through 5J1 pins A and B.

High voltage rectifier bridge 5CR1 supplies a positive 350 volt unregulated output. High voltage regulator control 5V3A adjusts the conduction of high voltage regulators 5V1 and 5V2, enabling them to supply the required load current at a regulated positive output of 250 volts. Low voltage regulator 5V4 provides the reference voltage for operating high voltage regulator control 5V3A.

Low voltage bridge rectifier 5CR2 supplies a negative output voltage to low voltage regulator 5V4. Output voltage variations are amplified by error amplifier 5V6B, and applied through

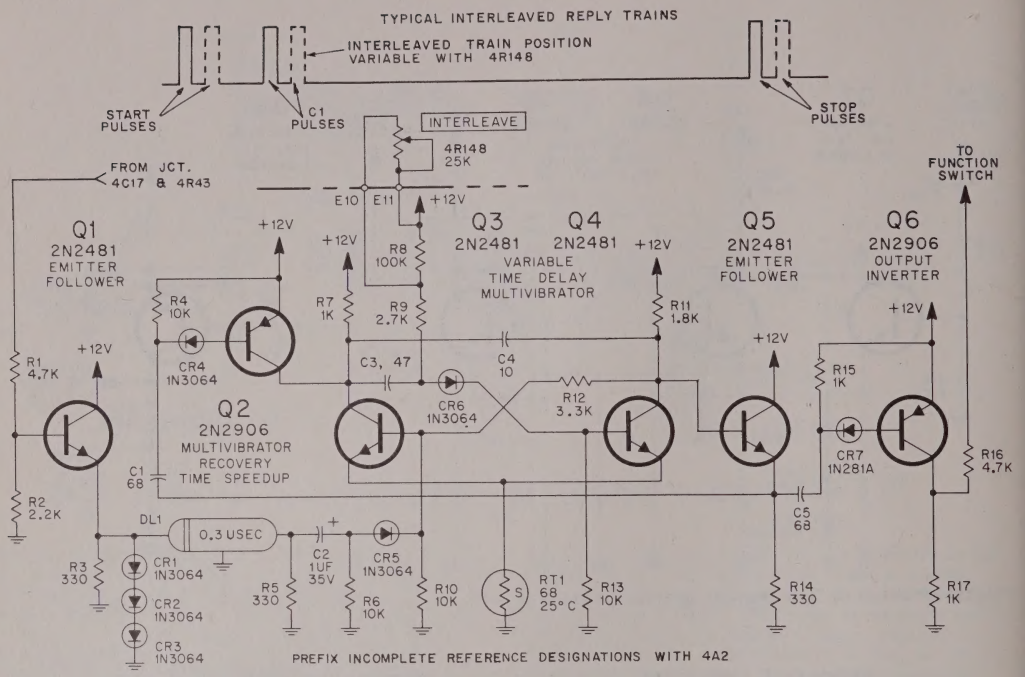


Figure 4-88. Interleave Circuit, Simplified Schematic Diagram

coupling diode 5V7 to low voltage regulator control 5V6A. Low voltage regulator control 5V6A adjusts the output of low voltage regulator 5V4 to provide a regulated negative 150-volt output. Reference diode 5V5 supplies a reference voltage for operation of error amplifier 5V6B and low voltage regulator control 5V6A. An input adjustment to error amplifier 5V6B permits setting the regulator output to the desired negative 150-volt value.

The regulated negative 150-volt supply is used as the source voltage for the regulator diode 5CR3 and regulator diode 5CR4. These two shunt regulator diodes provide regulated negative 4-volt output from regulator diode 5CR4 and regulated negative 35-volt output from regulator diode 5CR3.

(a) 115 VOLT INPUT CIRCUIT ANALYSIS. - The test set is designed to operate on 115-volt, 45 to 420 Hz power. Power is connected into the test set at connector 5J1 located in the TS-1253A panel-chassis assembly. Figure 4-89 is a block diagram of the panel-chassis assembly, showing the routing of ac power to power transformer 5T1. Thermostat 5S1 is provided to open the input power circuit when the case temperature rises above 74°C (166°F). Thermostat 5S4 opens the blower circuit when the temperature drops below -29°C (-20F). Interlock 5S2 opens the power transformer primary circuit when the equipment is removed from the cabinet. This interlock has a lock pin which can be set to hold the interlock closed when the equipment is being serviced out of the case. Fuses 5F1 and 5F2 are rated at 5 amperes, and their holders are equipped with neon lamps which glow when the fuses are open. Terminals 1 and 3 on power transformer 5T1 (figure 5-59) are normally connected to the ac line for operation between 102 and 127 volts. When the line voltage is below 102 volts, terminals 1 and 2 are used. When the line voltage is above 127 volts, terminals 1 and 4 are used.

(b) NEGATIVE 150-VOLT CIRCUIT ANALYSIS. - Figure 4-90 is a schematic diagram of the negative dc supply circuit. Regulated voltages of -150, -35, and -4 volts are provided by this circuit for use as bias voltages in the test set. Low voltage bridge rectifier 5CR2 is connected across the 260 volt ac winding of transformer 5T1 (figure 5-59). Silicon rectifiers are used in 5CR2 because they provide high efficiency, low internal voltage drop, low heat dissipation, and greater compactness than could be obtained with other types of rectifiers. The rectifier output is filtered by reactor 5L2 and capacitors 5C1B and 5C4A. Resistors 5R15, 5R16, 5R35, and 5R36 limit the initial surge of charging current through rectifier 5CR2 into 5C18 when power is first applied to the unit. These surge-limiting resistors are necessary when a capacitor-input filter is used in order to prevent damage to the rectifier from the initial charging surge into the capacitor.

The positive output voltage of the recitifer is fed to the plate of series low voltage

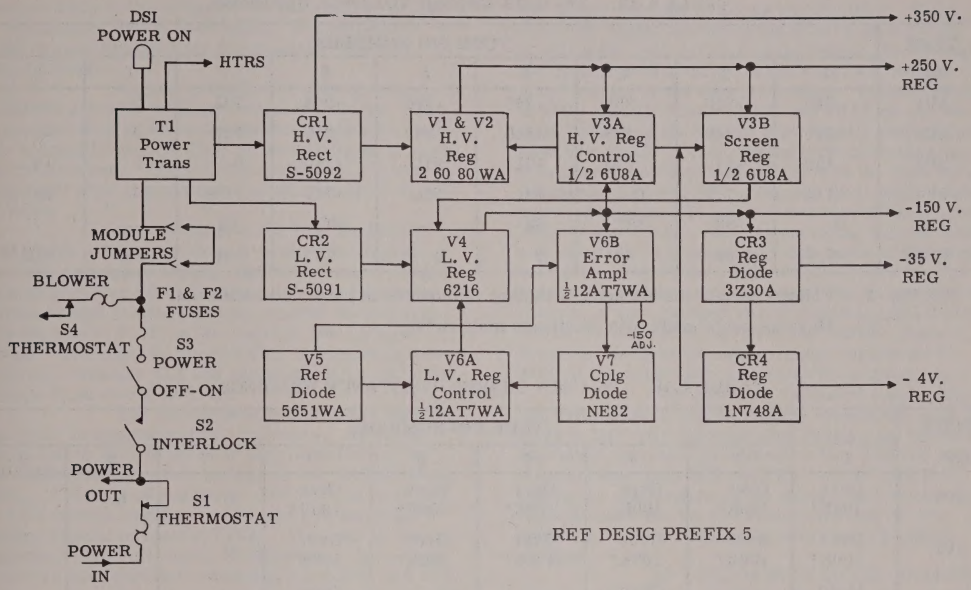


Figure 4-89. TS-1253A/UP Panel-Chassis Assembly, Block Diagram

regulator 5V4 and resistor 5R17 in parallel in the ground leg of the circuit. Under typical operating conditions, the voltage drop across 5V4 and 5R17 is in the vicinity of 100 volts. Tube 5V4 functions as a variable resistance which increases when the line voltage rises or the load current drops, and conversely decreases when the line voltage drops or the load current increases. This internal resistance and the resulting voltage drop of 5V4 is a function of its grid bias. The grid bias voltage is derived from a sample of the negative output of the voltage supply.

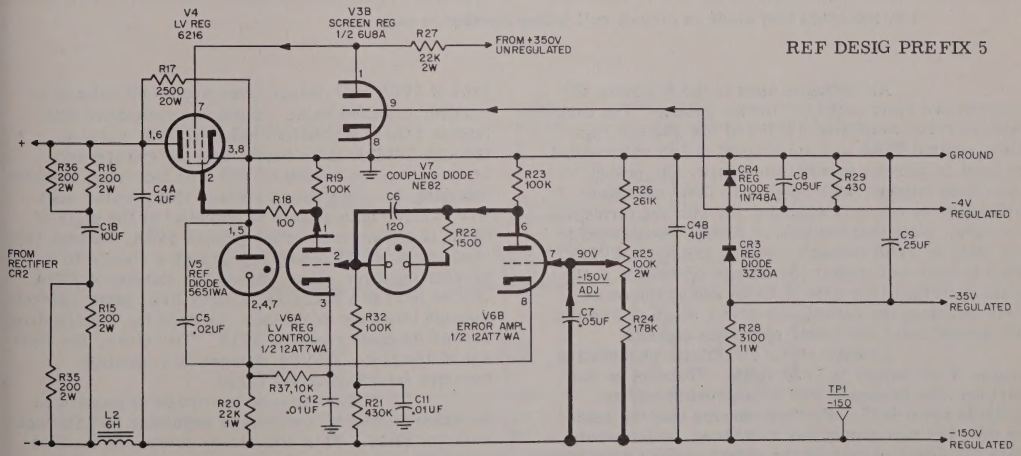


Figure 4-90. -150 Volt Regulator Circuit, Simplified Schematic Diagram

TABLE 4-17. TS-1253A CHASSIS VOLTAGE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
5V1	+240	+340	+255	+240	+350	+255	FIL	0	--
5V2	+240	+340	+255	+240	+350	+255	FIL	0	--
5V3	+150	-13	+270	FIL	FIL	+240	0	0	-4
5V4	+115	-7.7	0	FIL	FIL	+115	+150	0	NC
5V5	0	-88	NC	88	0	NC	-88	--	--
5V6	-7.7	-90	-88	0	0	-28	-90	-88	FIL

NOTES: 1. Voltage measurements taken with plug-in modules in place and connected.

2. Measurements made with electronic multimeter.

TABLE 4-18. TS-1253A CHASSIS RESISTANCE READINGS

TUBE NO.	TUBE PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
5V1	Over 100K*	Over 100K*	Over 100K*	Over 100K*	Over 100K*	Over 100K*	0	0	--
5V2	Over 100K*	Over 100K*	Over 100K*	Over 100K*	Over 100K*	Over 100K*	0	0	--
5V3	Over 100K*	220K	Over 100K*	0	0	Over 100K*	0	0	430Δ
5V4	18K	100K	0	0	0	18K	Over 100K*	0	NC
5V5	0	70K	NC	70K	0	NC	70K	--	--
5V6	100K	800K	240K	0	0	100K	170K*	70K	0

NOTES: 1. Resistance measurements taken with all plug-in units removed and disconnected.

2. * Indicates that resistance readings will depend upon electrolytic capacitor leakage and upon ohmmeter polarity and voltage.

3. Δ Indicates that diode in circuit will cause reading to vary.

All voltages used in the following discussion are referenced to chassis ground. The cathodes of error amplifier 5V6B and low voltage regulator control 5V6A are maintained at -85 volts with respect to chassis ground; therefore, any change in their grid voltage (with respect to their cathodes) will have the effect of changing the current through the tube. Note that the grid of 5V6A is connected to the plate of 5V6B through coupling gas diode 5V7. This is done to transfer the change of voltage at the plate of 5V6B to the grid of 5V6A and at the same time maintain the cathode-to-grid voltage of 5V6A at the proper level for linear operation of 5V6A.

Assume static conditions whereby the output of the supply is -150 volts. Voltages on the various tube elements will be approximately as given in table 4-17. Further assume that the load on the -150 volt supply has increased, which would have the effect of making the output voltage drop from -150 volts to a smaller negative value. Since the full voltage output of the regulated supply is divided across 5R24, 5R25, and 5R26, the voltage at the grid of 5V6B will change from about -90 volts to a smaller negative value. Since the cathode of this tube is held at a constant value by 5V5, current through 5V6B will increase, and the voltage drop across its plate resistor 5R23 will increase, thereby changing the plate output voltage to a greater negative value. This change in potential at the plate of 5V6B is transferred to the grid of 5V6A, through the coupling diode 5V7, and appears as a change to a greater negative value. Since the cathode of 5V6A is also held at a constant value by 5V5, plate current through this tube decreases, as does the voltage drop across its plate resistor 5R19. Therefore, the voltage at the plate of 5V6A changes to a smaller negative (more positive) value.

This change in voltage is coupled to the control grid of low voltage regulator 5V4 through resistor 5R18. This effectively decreases the 5V4 grid bias and lowers the internal resistance of the tube. The lowered resistance of 5V4 causes the supply voltage to the load to rise to the preset 150 volt level. At this time the grid voltage of 5V6B

changes back to the original -90 volts and a condition of equilibrium exists once again. Potentiometer 5R25 is used to adjust for the nominal -150 volt output voltage.

Regulated bias potentials of -4 and -35 volts are provided by Zener regulator diodes. The characteristics of these diodes enable them to maintain a specific voltage drop under conditions of varying load current. Diode 5CR4 maintains a 4-volt drop, and 5CR3 maintains an additional drop of 31 volts.

(c) POSITIVE 250 VOLT CIRCUIT ANALYSIS.- Figure 4-91 is a schematic diagram of the +250 volt power supply regulator circuit. High voltage rectifier 5CR1 (figure 5-59) is a full-wave silicon bridge rectifier having general characteristics similar to 5CR2 in the negative low voltage supply. The input to the rectifier is nominally 400 volts ac. Reactor 5L1 and capacitor 5C1A filter the voltage from rectifier 5CR1.

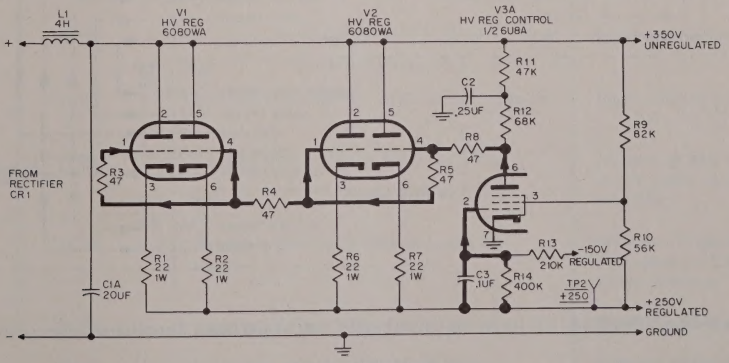
The unregulated output of the rectifier and filter is approximately +350 volts. Although connected to each of the four plug-in units in the TS-1253A/UP unit, this voltage is not used in these units. A source of regulated +250 volts is provided by high voltage regulators 5V1 and 5V2 and high voltage regulator control 5V3A. The load on the regulated +250 volt supply is effectively connected in series with parallel-connected tubes 5V1 and 5V2.

Operation of this circuit is as follows: Since the load current flows through tubes 5V1 and 5V2, a change in their internal resistance will change the voltage drop across them and thereby change the load voltage. The control of the internal resistance of these tubes is a function of the plate voltage of high voltage control 5V3A, and the plate voltage of 5V3A is a function of the control-grid-to-cathode potential of that tube. Note that the control grid of this tube is tied between regulated -150 volts and regulated +250 volts through resistors 5R13 and 5R14. This places the grid at a potential of approximately -15 volts dc, and allows the tube to act as an amplifier. If the +250 volt supply voltage tends to drop as a result of increased load current or decreased line voltage, the control grid becomes more negative, and the plate current of the tube decreases. This decrease in plate current through 5R11 and 5R12 causes the plate voltage of the tube to rise slightly toward the +350 volt supply. This upward shift of voltage is transferred to the paralleled grids of the high voltage regulators 5V1 and 5V2, reducing their plate resistance. A decrease in plate resistance of these tubes reduces the voltage drop across them, and the +250 volt regulated line potential rises again to the nominal value. Should the +250 volt line output tend to rise instead of drop, the action of the circuit is the reverse of that outlined above. Resistors 5R1 through 5R8 are connected in the grid and cathode leads of the parallel-connected high voltage regulators to prevent the occurrence of parasitic oscillations.

The +250 volt regulated supply does not have separate output voltage adjustment such as 5R25 in the -150 volt regulated supply, but instead is dependent upon the adjustment of the -150 volt supply. Bypass capacitors 5C2 and 5C3 remove high frequency ac components in the supply load circuit and thereby make the circuit responsive only to low frequency and dc changes in power supply output voltage.

(d) FILAMENT CIRCUIT ANALYSIS.- Power transformer 5T1 has three 6.3 volt and two 12.6 volt filament (tube heater) windings (figure 5-59). The two 12.6 volt windings are center tapped and are connected as two 6.3 volt windings in series. The power from these filament windings is distributed to the tubes in the power supply and to the four plug-in units in the TS-1253A/UP assembly through inter-unit connectors 5J2 through 5J5.

(e) DC CIRCUIT ANALYSIS. -Refer to figure 5-59 for the overall schematic diagram of the TS-1253A panel-chassis assembly. The five dc potentials of the power supply, -4, -35, -150, +250



REF DESIG PREFIX 5

Figure 4-91. +250 Volt Regulator Circuit, Simplified Schematic Diagram

and +350 volts, are connected to each of the four plug-in units through the inter-unit connectors. Although available, the unregulated +350 volt potential is not used in any of the four units. The +250 volt terminals on the Display, Sweep and Intensity Mark, Crystal Mark and Sync, and the SIF Coder units are decoupled from the other units by separate filters consisting of 5R30 and 5C10A, 5C10B, and 5R31 and 5C10C, respectively, This decoupling is used to suppress interaction of pulse currents and voltages generated in the units.

(f) SIGNAL AND CONTROL CIRCUIT ANALYSIS. - Several signal and control circuits in the TS-1253A/UP assembly are connected via the unit connectors. These connections are shown in figure 4-92. The crystal markers from the Crystal Mark and Sync unit are fed to the Display unit for presentation on the screen of the CRT. The delayed and sweep trigger pulses are fed from the Sweep and Intensity Mark unit to the Display unit for display purposes when the DELAY STROBE SWEEP and STROBE TRIGGER switches on the front panel of the Sweep and Intensity Mark unit are momentarily depressed. One connection enables the HOR (horizontal) centering control, located on the front panel of the Display Unit, to control a dc voltage to the sweep circuits in the Sweep and Intensity Mark unit for the purpose of controlling the horizontal centering of the oscilloscope pattern. Marker gate pulses from the Sweep and Intensity Mark unit to the Crystal Mark and Sync unit, delayed and sweep trigger pulses from the Crystal Mark and Sync unit to the Sweep and Intensity Mark unit are also connected through the interunit connectors. The delayed and 0 trigger pulses from the Crystal Mark and Sync unit are also fed to the SIF Coder, but are not internally connected beyond this point. The delayed trigger pulses from the Crystal Mark and Sync unit are fed to terminal J on 5J1 for application to the Interrogation Coder.

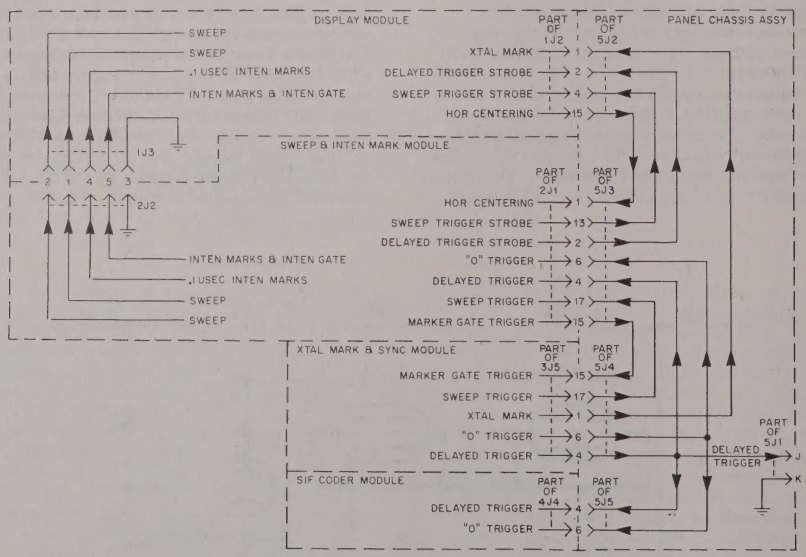


Figure 4-92. TS-1253A/UP Interunit Signal and Control Circuit, Simplified Schematic Diagram

TABLE 4-19. AN/UPM-98A SERVICE ADJUSTMENTS

NAME	REF. DESIG.	LOCATION	FUNCTION
		DISPLAY UNIT	
0.1 volts/ In Trimmer	1C1	".1" contacts of VOLTS/IN switch 1S2	Input attenuator equalizing
20 volts/ In Padder	1C5	"20" contacts of VOLTS/IN switch 1S2	Input attenuator equalizing
20 volts/ In Trimmer	1C8	Across 1C6 in "20" attenuator network	Input attenuator equalizing
0.2 volts/ In Padder	1C9	To ground from 1S2 ".2" contact	Input attenuator equalizing
0.2 volts/ In Trimmer	1C12	".2" contacts of 1S2	Input attenuator equalizing
10 volts/ In Padder	1C13	To ground from 1S2 "10" contact	Input attenuator equalizing
10 volts/ In Trimmer	1C16	Across 1C14 in "10" attenuator network	Input attenuator equalizing
0.5 volts/ In Padder	1C17	To ground from 1S2 " 5" contact	Input attenuator equalizing
0.5 volts/ In Trimmer	1C20	Across 1C18 in ".5" attenuator network	Input attenuator equalizing
2 volts/ In Padder	1C21	To ground from 1S2 "2" contact	Input attenuator equalizing
2 volts/ In Trimmer	1C24	Across 1C30 in "2" attenuator network	Input attenuator equalizing
1 volt/ In Padder	1C25	To ground from 1S2 "1" contact	Input attenuator equalizing
1 volt/ In Trimmer	1C28	Across 1C26 in "1" attenuator network	Input attenuator equalizing
5 volts/ In Padder	1C29	To ground from 1S2 "5" contact	Input attenuator equalizing
5 volts/ In Trimmer	1C32	Across 1C22 in "5" attenuator network	Input attenuator equalizing
Phase Adjust	1C34	Grid of Video Phase Inverter 1V1A	Adjusts phase relationship at the input to the video amplifier
Freq. Adjust	1C36	Between plate of 1V4B and grid of 1V2A	Adjusts frequency response by means of feed back to video drivers
0.1 volts/ In Padder	1C61	To ground from 1S2 ".1" contact	Input attenuator equalizing
Gain Calibrate	1R40	In series with VIDEO SENS control 1R40	Adjusts video driver gain
Anode Set	1R70	Primary of 1T1	Adjusts CRT anode voltage

TABLE 4-19. AN/UPM-98A SERVICE ADJUSTMENTS (Continued)

NAME	REF. DESIG.	LOCATION	FUNCTION
		SWEEP AND INTEN. MARK UNIT	
1 mHz Freq. Adjust	2L2	Grid of 1 mHz Osc. 2V7B	Adjusts frequency of 1 mHz Osc. 2V7B
Sweep Amplitude	2R33	Cathode of 2V2B	Adjusts feedback from 2V2B to sweep gate MV 2V3 to vary length of horizontal CRT trace
Osc. Feedback Adj.	2R50	Cathode of 1 mHz Osc. 2V7B	Adjusts cathode feedback to 1 mHz Osc. 2V7B
5 usec Adjust	2R73	Grid of 2V11A	Varies bias on grid of 2V11A to adjust 5 usec countdown
50 usec Adjust	2R86	Grid of 2V11B	Adjusts bias on grid of 2V11B
10 mHz Adjust	2T3	Grid of 2V10A	Adjusts tuned circuit in grid of 2V10A
		XTAL MARK AND SYNC UNIT	
Sweep Delay Adj.	3C44	"1-11" contact of Sweep Delay switch 3S3	Sets minimum sweep time delay for positions 3-5 of sweep delay range
Sweep Delay Adj.	3C58	"11-21" contact of 3S3	Same as above for "11-21" range
PRF Adjust	3R40	In series with PRF control 3R38A	Adjust range of PRF countdown circuit
		SIF CODER	
Delay line Pickoff Coils	4L10-4L26	On 4DL3-7	Adjust delay at each pickoff point
Sub Pulse Ampl.	4R32	Cathode of 4V5A	Adjusts substitute pulse height
Width Adj.	4R47	In series with Pulse Width control 4R49	Sets range of code pulse width adjustment
Sub Pulse Pos. Adj.	4R141	Cathode of Sub Pulse Ampl 4V2B	Sets range of Sub Pulse position adjustment
Emergency Code Adj.	4R147	Grid of Emer. Gate MV 4V1	Adjusts gate length
		TS- 1253A CHASSIS	
-150 V Adjust	5R25	Grid of Error Ampl. 5V6B	Adjusts voltage on 5V6B grid to set nominal output voltage

TABLE 4-19. AN/UPM-98A SERVICE ADJUSTMENTS (Continued)

NAME	REF. DESIG.	LOCATION	FUNCTION
		SM - 197A CHASSIS	
+300 V Adjust	8R35	Grid of Reg. Ampl. 8V5	Adjusts voltage on 8V5 grid to set nominal output voltage
		CAL - CONTROL UNIT	
Shape Adj.	9C26	Lug No. 3 of 9S2A	Compensates for test lead capacitance
ALC Adj.	9R3	Input Integrator diode 9CR1 Cathode	Sets ALC input threshold
Pulse Width Adj.	9A4R25	Base of Pulse Width Stretcher 9A4Q7	Adjust pulse width
Mode 4 Ampl. Adj.	9A4R27	Base of Output Emitter Follower 9A4Q8	Sets Mode 4 decode output level
PRF 0-500	9R30	Plate of Cal. Ampl. 9V4A	Adjusts voltage to meter for calibration of 0-500 PRF scale
PRF 0-5000	9R31	Plate of Cal. Ampl. 9V4A	Adjusts voltage to meter for calibration of 0-5000 PRF scale
CAL Adjust	9R36	Meter Select switch 9S3	Supplies meter calibrating voltage
WM Adjust	9R61	Plate of 9V7B	Adjusts gain of wave meter cathode follower 9V7B
		INTERROGATION CODER	
Clock Timing Adj.	12A1C8	Across 12A1L1 in collector of 12A1Q6	Tunes clock oscillator
	12A5C5	Collector of Osc. 12A5Q1	Tunes Osc. Transformer 12A5T1
	12A5C9	Collector of Buffer 12A5Q2	Tunes buffer transformer 12A5T2
	12A5C12	Collector of 1st Gated Ampl. 12A5Q3	Tunes amplifier transformer 12A5T3
	12A5C19	Collector of 2nd Gated Ampl. 12A5Q4	Series-tunes 12A5L2
	12A5C22	In series with 12A5L4	Series-tunes 12A5L4
	12A5C23	In series with 12A4L3	Adjusts coupling
	12A5C24	From 12A5L5 to ground	Series-tunes 12A5L5
	12A5C25	Between 12A5L4 and 12A5L6	Series-tunes 12A5L6

TABLE 4-19. AN/UPM-98A SERVICE ADJUSTMENTS (Continued)

NAME	REF. DESIG.	LOCATION	FUNCTION
		INTERROGATION CODER (Cont.)	
	12A5C26	12A5L14 to ground	Series-tunes 12A5L14
	12A5C28	12A5T6 primary to ground	Series-tunes 12A5T6 primary
	12A5C29	12A5T6 secondary to ground	Series-tunes 12A5T6 secondary
	12A5C32	12A5V2 cathode to 12A5L14	Series-tunes 12A5L14
	12A5C33	12A5V2 cathode to ground	Tunes 12A5V2 cathode
	12A5Z1	12A5V2 plate cavity	Tunes RF ampl. plate circuit
ISLS 2 usec Adj.	12A6R11	Collector of 12A6Q3	Adjusts length of ISLS Delay MV pulse
40 usec Adj.	12A6R21	Collector of 12A6Q6/Q7	Adjusts length of 40 usec delay MV pulse
Tag Ampl. Adj.	12A6R69	Emitter of 12A6Q22	Adjusts amplitude of reset pulses
21 usec Delay Adj.	12A6R76	Collector of 12A6Q23/Q24	Adjusts length of 21 usec delay MV pulse
ISLS Balance Adj.	12R9	In series with ISLS Level Control 12R10A	Adjusts range ISLS level control
+25V Adj.	12R24	Base of 12Q2	Adjusts voltage on 12Q2 to set nominal output voltage
+12V Adj.	12R32	Base of 12Q3	Adjusts voltage on 12Q3 to set nominal output voltage

TABLE 4-20. UPM-98A TEST POINTS

NUMBER	LOCATION	FUNCTION MONITORED
	SWEEP AND INTENSITY MARK UNIT	
2TP1 (2J3)	2P1 pin 10	+250 V
2TP2 (2J4)	2P1 pin 20	-35 V
2TP3 (2J5)	2P1 pin 8	-150 V
	XTAL MARK AND SYNC UNIT	
3TP1 (3J6)	3P1 pin 10	+250 V
3TP2 (3J7)	3P4 pin 8	-150 V
	SIF CODER	
4TP1 (4J5)	4P4 pin 10	+250 V
4TP2 (4J6)	4P4 pin 20	-35 V
4TP3 (4J7)	4P4 pin 8	-150 V
4TP4 (4J8)	4P4 pin 3	-4 V
	TS-1253A CHASSIS	
5TP1 (5J6)	Junction 5L2, 5C4A	-150 V
5TP2 (5J7)	Junction 5V2 cathode resistors 5R6, 5R7	+250 V
	SM-197A CHASSIS	
8TP1 (8J27)	Junction 8R20, 8C16	-30 V
8TP2 (8J26)	Junction 8R21, 8R22	-5 V
8TP3 (8J24)	Junction 8V4 cathode resistors 8R30, 8R27	+300 V
8TP4 (8J25)	Junction 8R41, 8J23-5	+105 V
	CAL-CONTROL UNIT	
9TP1 (9J5)	9P1-pin 3	+300 V

TABLE 4-20. UPM-98A TEST POINTS (Cont.)

NUMBER	LOCATION	FUNCTION MONITORED
	CAL-CONTROL UNIT (Cont.)	
9TP2 (9J6)	9P1-pin 5	+105 V
9TP3 (9J7)	9P1-pin 10	-30 V
9TP4 (9J8)	9P1-pin 12	-5 V
12A1TP1	Collector of clock output Amplifier 12A1Q9	Clock Pulses
12A1TP2	Emitter of Sub Pulse Blocking Oscillator 12A1Q13	Substitute pulses
12A1TP3	Base of Recycle Trigger Amplifier 12A1Q2	Recycle triggers
12A1TP4	Emitter of Line Drive Blocking Oscillator 12A1Q3	Line drive
12A1TP5	Collector of Sub Pulse Shaper 12A1Q16	Substitute pulses
12A2TP1	Termination of Delay Line 12A2DL1	Delay line output
12A2TP2	Input to Delay Line 12A2DL1	Delay line drive
12A6TP1	Collector of Reset Tag Binary Generator 12A6Q19	Reset tag pulses
12A6TP2	Collector of 40 usec Delay MV 12A6Q8	40 usec delayed trigger
12A6TP3	Collector of 12A6Q12/12A6Q13	Code trigger gate
12A6TP4	Collector of 12A6Q5	ISLS delayed trigger
12A6TP5	Cathodes of 12A6CR1 and 12A6CR2	Code output trigger
12TP1	Conn. 12J2 pin 10	-30 volts
12TP2	Anode of 12VR4	-12 volts
12TP3	Emitter of 12Q3	+12 volts
12TP4	Emitter of 12Q1	+25 volts
12TP5	Conn. 12J2 pin 3	+300 volts

SECTION 5

MAINTENANCE

5-1. FAILURE, AND PERFORMANCE AND OPERATIONAL REPORTS.

The Naval Electronic Systems Command no longer requires the submission of failure reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipments to the extent required by existing directives. All failures shall be reported for those equipments requiring Failure Reports.

5-2. PREVENTIVE MAINTENANCE.

a. MAINTENANCE STANDARDS. - Performance criteria to be used as maintenance standards are given with the various minimum performance tests in this section. When the equipment has normal indications in all the performance tests, it meets these standards. If a test results in an abnormal indication, perform the appropriate trouble-analysis procedures (Section 4) to locate the cause of the malfunction. When the abnormal indication has been corrected to meet these standards, the equipment is ready for return to service.

(1) TEST EQUIPMENT REQUIRED. - Many internal adjustments of the Radar Test Set AN/UPM-98A can be accomplished by using the oscilloscope, trigger generator, pulse counter and other facilities of the radar test set itself, if the required section is operating properly. Otherwise, external test equipment must be used. Separate test equipment is also required to make some of the internal adjustments. Table 1-7 lists all test equipment required for the various maintenance procedures in this section.

(2) TEST SETUP. - Separate test setup procedures and diagrams are given as required for each of the main functional sections.

b. INSPECTION. - Instructions are provided for examination of the assemblies, subassemblies, and parts for damage, wear, deterioration, and defects. Carefully make a visual examination of the chassis of all the plug-in units and major components. Table 5-1 provides guide lines for visual and mechanical examination of electrical and electronic parts. Final determination of whether or not the part is properly functioning can be made only by an operational check of the assembly or the complete equipment.

When inspecting and testing the units of Radar Test Set AN/UPM-98A, avoid moving the wiring unless absolutely necessary. Any excessive change in position of the wiring may cause undesirable cross-talk between the various circuits of the equipment. Many circuits in the equipment are affected by changes in tube constants, therefore, unnecessary interchanging of tubes should be avoided. If tubes are changed unnecessarily, extensive readjustment and recalibration of the test set may be required.

Guidelines for inspection of mechanical parts and assemblies subject to wear and damage are given in following paragraphs.

(1) RADAR TEST SET TS-1253A/UP. - After visual examination of the electrical and electronic parts on each chassis in accordance with instructions in table 5-1, proceed with the examination of mechanical parts and assemblies as described in following subparagraphs.

(a) DISPLAY UNIT.

Step 1. Check that VIDEO SENS control shaft protruding through the attenuator assembly is firmly fastened by setscrews to the flexible extension shaft inside the unit attaching to Video Sens potentiometer 1R41. Check that the flexible shaft is in good condition.

Step 2. Check that the stop spring on the 1R41 mounting bracket engages the groove on the stop cam on the flexible shaft when the VIDEO SENS knob is in the fully cw position (CAL).

Step 3. Check that tube retainers of 1V5 and 1V6 are held firmly in place by their springs.

Step 4. Check that the five wire connections to contacts on the CRT neck are well made.

(b) SWEEP AND INTENSITY MARK. UNIT. - There are no mechanical parts or assemblies on this unit which are subject to wear; therefore, a careful check of general condition of the chassis will suffice.

(c) CRYSTAL MARK AND SYNC UNIT.

Step 1. Check that controls of delay line assemblies 3Z1 and 3Z2 turn without excessive binding through entire range of pickoff coil travel.

Step 2. Check that stop screws with fiber bushings in the slot on the delay line assemblies are not bent or damaged. Check that wires at ends of delay lines and on pickoff coils are not broken.

Step 3. Check that U-shaped wire clips joining variable resistor shafts to associated switch shafts are

Table 5-1. Visual and Mechanical Inspection of Electronic Parts

NO.	PART	METHOD OF INSPECTION
1	Resistors, Composition	Replace if discolored, cracked or burned
2	Resistors, Variable	Replace if shaft is excessively loose, stops not operative, or binding occurs when turned.
3	Resistors, Wirewound	Replace if burned and/or discolored
4	Capacitors, Paper Dielectric	Replace if wire leads loose or body cracked
5	Capacitors, Mica Dielectric	Replace if leads loose or body cracked
6	Capacitors, Electrolytic	Replace if there is evidence of electrolytic leakage
7	Transformers	Replace if leads loose or mechanically damaged
8	Coils	Replace if there is evidence of coil being overheated
9	Delay Lines	Replace if leads are broken or excessively loose
10	Switches	Replace if any contacts are broken or switch cannot be set to all positions without excessive binding. Also, replace if detented positions do not lock in properly.
11	Connectors	Replace if any contacts are broken or insulator body is cracked or damaged
12	Electrical Wiring	Replace or repair if insulation is broken or wire is too short to reach connection without tension
13	Tube Sockets	Replace or repair if contacts are broken or insulator body cracked or burned

firmly in place and not distorted.

Step 4. Check that retainers on sockets for crystals 3Y1 and 3Y2 are not bent and that the crystals are retained properly.

(d) SIF CODER.

Step 1. Check that SUB PULSE POS control can be turned through its range without binding.

Step 2. Check that the knob seats firmly in the five detent positions (-.7, -.2, 0, +.2, and +.7 microseconds.)

Step 3. Check that the stop screws with fiber washers in the slot of delay line assembly 4Z1 are not bent and that they operate properly.

Step 4. Check that pickoff coil locknuts on delay lines 4DL3 through 4DL7 are tight. Do not move any of the coils; if they are moved, complicated readjustment will be required to restore the test set to proper operation.

(2) CODER SIMULATOR SM-197A/UPM-98.- After visual examination of the electrical and electronic parts on the chassis in accordance with instructions in table 5-2, proceed with detailed examination of assemblies and subassemblies as described in following subparagraphs.

(a) RF OSCILLATOR ASSEMBLY 8A1. - The proper operation of the rf oscillator depends upon the presence of modulation pulses from modulator tube 12V3 at the plate of rf oscillator tube 8V2. The presence of modulation pulses can be checked directly at 8V2 by removing the screw cap at rear of oscillator housing and connecting the oscilloscope probe to the plate of 8V2. For this test, set oscilloscope sensitivity to 20 volts per inch and use Test Lead MX-2681/UP (video probe) with attenuation switch in 10:1 position. The amplitude of the modulation pulse is variable up to about 175 volts, depending upon the ALC setting. If a modulation pulse is present at the plate, and 8V2 filament is heated by 6.3 vac, the absence of rf oscillator output can be caused by failure of parts and contacts within the rf oscillator assembly.

After disassembly of the rf oscillator, inspect every part for excessive wear or damage. Refer to table 5-2 for the method of inspection and allowable limits.

(b) ALC/ATTENUATOR ASSEMBLY 8A2. - If the rf output level at SG OUT connector 8J6 is incorrect with respect to the setting of the output ATTENUATION dial, the trouble may be traced to a malfunction in the automatic level control circuitry. This circuitry includes ALC tube 8V1 inside ALC/Attenuator Assembly, and tubes 9V1 through 9V3, in the Cal-Control unit. Missing or erratic output at SG OUT connector also can be caused by worn contacts or other mechanical failures in the ALC/Attenuator Assembly. Table 5-3 provides inspection procedures and allowable limits.

(c) WAVEMETER ASSEMBLY 8A3. - The wavemeter is a precisely calibrated device and

Table 5-2. Inspection of RF Oscillator 8A1 Parts

IDENT. NO. (Figure 5-5)	PART	METHOD OF INSPECTION
4	Insulating Screws	Replace if out of shape or threads are stripped.
8	Insulator Ring	Replace if broken or distorted.
9	Terminal Stud	Replace if bent or insulation broken.
10	Contact Ring	If operation intermittent because of lack of spring action in fingers, carefully increase diameter of contact finger ring by gently bending each contact finger. Replace entire contact ring if some fingers are broken or contact surface is corroded.
11	Contact Ring	Same as item 10 above.
12	Tuning Rods	Replace if rods are bent or contact surface is corroded.
13	Tuning Rods	Same as item 12 above.
14	Cavity	If contact surfaces are slightly corroded or scratched, restore surface by polishing with a piece of soft leather. Remove deeper blemishes by re-honing, followed up by new silver plating. Otherwise, replace entire cavity.
19	Filter Body	Replace if filter fits into cavity extremely loosely and causes rf leakage.
20	Wire	Replace if too short to reach terminal stud (item 9) without tension.
24	Coupling Assembly	Replace if shorted or internal resistor 8R3 measures other than 47 ohms $\pm 10\%$.
25	Cable Assembly 8W7	Inspect for loose rf cable fit into termination. Tighten clamp nut. Check for short between center and outer conductors.
27	Terminal Stud	Replace if bent or broken.
28	Wire	Replace if too short.
29	Contact Rod	Replace if bent or damaged.
33	Contact Spring	Replace if out of shape, worn, or corroded.
37	Lead Screw	Replace if, with backlash nut properly adjusted, torque varies or shaft starts binding in spots.
39	Backlash Nut	Similar to item 37 above.
42	Tuning Shaft	Similar to item 37 above.
43	Ball Bearings	Replace if the inner ring does not turn freely or there is evidence of side play.
46	Filter Body	Same as item 19 above.
55	Packing Gland	Replace if out of shape or worn.

is constructed for long and reliable service. However, if, after prolonged use or storage in adverse conditions, a lack of sharpness in tuning is experienced, it may be caused by low "Q" in the wavemeter cavity as a result of dirt or corrosion. Changes in calibration may also occur due to mechanical wear or damage. Low amplitude of wavemeter output which appears without loss of tuning sharpness is usually due to a faulty crystal 8CR1 or defective wavemeter integrator circuitry associated with 9V6 and 9V7.

If the attenuator shaft cannot be turned through its range without exceeding the specified torque or if the shaft starts binding in certain spots, with proper setting of the backlash nut, the lead screw and/or the threaded tuning shaft must be replaced. Check other parts of the wavemeter for excessive wear or mechanical damage.

(d) DEMODULATOR ASSEMBLY 8A4. - The demodulator assembly consists basically of the demodulator tube 8V3 encased in a suitable mounting and connected through a small capacitor to the LP IN connector on the front panel. An attenuation network of a rather complex design is also included in the assembly so that the demodulator tube can be fed a signal at a reduced level from the HP IN connector. The attenuation network is assembled in a very

Table 5-3. Inspection of ALC/Attenuator 8A2 Parts

IDENT NO. (Figure 5-6)	PART	METHOD OF INSPECTION
5	Tube Socket	Replace if insulator is cracked or damaged.
8	Contact Ring	If contact fingers do not fit tightly around electron tube, bend fingers gently to tighten. Replace contact ring if fingers are broken or excessively corroded.
10	Cable Assembly	Inspect for loose rf cable fit into termination. Tighten clamp nut. Check for short between center and outer conductors.
12	Contact Assembly	Replace if star-shaped contact is broken or distorted, or metal contact strip is damaged.
13	Insulating Spacer	Replace if damaged.
15	Filter Body	Replace if filter makes extremely loose fit with cavity and causes rf leakage.
16	Resistor 8R1	Replace if lead has been cut too short to reach proper contact (item 12).
22	Contact	Replace if worn or corroded. Also inspect inside of plunger cavity.
25	Contact Assembly	Replace if distorted or insulator is cracked or damaged.
26	Resistor 8R2	Replace if lead is too short or distorted to form a proper coupling loop as shown in figure 5-6.
29	Plunger	Replace if (with backlash nut properly adjusted and both sections of assembly properly aligned) torque varies or shaft binds in spots.
32	Backlash Nut	Same as item 29 above.
35	Lead Screw	Same as item 29 above.
36	Ball Bearings	Replace if the inner ring does not turn freely or there is evidence of side-play.

precise manner to obtain favorable standing wave conditions at the input connectors. If any of the electrical parts of the attenuator require replacement, be careful to install the new parts in the same positions as the old ones. Do not disturb the placement of any parts on the plate assembly. There are no moving parts subject to wear in the demodulator assembly, so replacement will be necessary only in case of mechanical damage or breakage of contact fingers.

(e) INTERROGATION CODER.

Step 1. Check that SUB PULSE POS control can be turned throughout its range without binding.

Step 2. Check that the knob locks in the five detented positions at -.7, -.2, 0, +.2, and +.7 scale markings.

Step 3. Check that the stop screws with fiber washers in the slot of the delay line assembly are not bent and that they operate properly.

Step 4. Check that U-shaped wire clip joining variable resistor shaft to associated switch shaft is firmly in place and not distorted.

(f) CALIBRATION-CONTROL UNIT. - See paragraph 5-2b(1)(d) step 4.

c. CLEANING. - Assemblies and subassemblies should be cleaned thoroughly after disassembly.

(1) CLEANING ELECTRICAL CHASSIS. - Clean both sides of all chassis containing electrical and electronic parts by brushing away dust and dirt with a soft brush. Because the wiring on all chassis has been installed during production so that interaction between sensitive circuits is kept to a minimum, be careful not to disturb wires during cleaning operations. Finish the cleaning of the chassis by using compressed air jet of moderate pressure (25 to 35 lb) to blow out any dust or dirt particles remaining between the parts.

(2) CLEANING MECHANICAL PARTS. - Wash mechanical parts needing cleaning in a bath of dry-cleaning solvent type II per specification P-S-661 (Federal Stock No. WM9160-S-4718-10). Use a small plastic or hair brush for loosening any embedded dirt or corrosion products on the parts. Sensitive parts, such as cavities, contacts, and contact fingers having corrosion products which cannot be removed by gentle brushing must be replaced. Do not use rough abrasives to clean these parts, as they will destroy polished surfaces and plating.

5-3. INTERNAL ADJUSTMENTS AND CALIBRATION.

a. GENERAL. - The functions of all the internal service adjustments in Radar Test Set AN/UPM-98A

are listed in table 4-19. The locations of these adjustments may be found by referring to the parts location illustrations in this section. The internal service adjustments are not intended to be used during operation of the test set. These adjustments should be made only by qualified maintenance personnel equipped with the specified test equipment. To insure proper operation of the test set, follow each procedure exactly as described. The notes between procedures indicate adjustments which are interrelated and must be performed in the given order.

b. SPECIAL TOOLS AND TEST EQUIPMENT REQUIRED. - No special tools are required to accomplish the procedures described in this technical manual. The assembly aid for assembling the pickoff coils on delay lines 3DL2, 3DL3, 4DL1, and 12DL1 can be fabricated locally from the information given in figure 5-1.

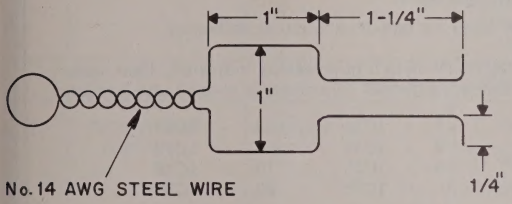


Figure 5-1. Pickoff Coil Assembly Aid

c. CABLE FABRICATION FOR SERVICING. - To align and calibrate the four plug-in units of Radar Test Set TS-1253A/UP, four servicing cable assemblies (figure 1-7) are required which normally are supplied with the equipment, but in some cases may be fabricated locally.

(1) CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-4963/UPM. - This is a servicing cable for connecting the removed plug-in units to their appropriate connectors in the panel-chassis of TS-1253A/UP. The cable assembly is of a special molded construction to insure ruggedness and durability.

(2) CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-4964/UPM. - This cable assembly is used to establish connection between two contact plates on the sides of the Display unit and the Sweep and Intensity Mark plug-in units of TS-1253A/UP when the units have to be operated while removed from the TS-1253A/UP panel-chassis. The cable consists of an assembly of two special connecting devices and 30 inches of specially spaced wiring harness. This cable assembly cannot be easily fabricated locally and should be procured in the assembled form.

(3) CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-6092/U. - This cable assembly is used to connect either the plug-in Cal-Control unit or the Interrogation Coder to the SM-197A Panel-Chassis Assembly when the unit has been removed for servicing. The cable assembly is of a special molded construction to insure ruggedness and durability.

d. RADAR TEST SET TS-1253A/UP ADJUSTMENTS. - To make service adjustments on plug-in units of the Radar Test Set TS-1253A/UP, pull out the applicable unit and connect it to the panel-chassis with cable assembly CX-4963/UPM which is supplied as an accessory with Radar Test Set AN/UPM-98A. If a connection is required between the two connector plates 1P3 and 2J2 on the Display and Sweep and Intensity Mark units, respectively, use cable assembly CX-4964/UPM. Before making adjustments, allow a 15-minute warmup time and place all operating controls in the preliminary settings listed in table 2-1. Procedures for making service adjustments on Radar Test Set TS-1253A/UP are given in table 5-4.

e. CODER SIMULATOR SM-197A/UPM-98 ADJUSTMENTS. - To make internal adjustments on the plug-in units of the coder simulator, pull out the applicable unit and connect it to the panel-chassis with cable assembly CX-6092/U which is supplied as an accessory with Radar Test Set AN/UPM-98A. Allow at least a 15-minute warmup time. Set all the controls to the preliminary control settings listed in table 2-1, unless otherwise indicated in the adjustment procedure. Procedures for making service adjustments on Coder Simulator SM-197A/UPM-98 are given in table 5-5.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		PANEL-CHASSIS ASSEMBLY	
1	-150 V ADJ (5R25)	Multimeter	1. Set multimeter to read negative volts. 2. Connect multimeter positive lead to 5TP1 (-150 V), and negative lead to chassis ground. 3. Adjust 5R25 for indication of -150 vdc.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		DISPLAY UNIT	
2	ANODE SET (1R70)	VTVM with HV Probe	1. Turn INT control fully ccw. 2. Connect VTVM negative lead to chassis ground and HV probe to terminal A1 of 1V7. 3. Adjust 1R70 for indication of +1500 vdc.
3*	FREQ ADJ (1C36) PHASE ADJ (1C34) GAIN CAL (1R40)	Square Wave Generator	1. Connect square wave generator output to VIDEO connection. 2. Set generator for 1000 Hz, 0.05 volt peak output. 3. Turn VOLTS/IN switch to .05. 4. Turn VIDEO SENS control to CAL. 5. Adjust SWEEP SPEED controls for single pulse display. 6. Adjust 1C34 and 1C36 for flat-topped pulse reproduction with 4% overshoot. 7. Adjust 1R40 for one-inch vertical deflection.
4*	Input Attenuator Alignment 1C1 1C12 1C20 1C28 1C32 1C24 1C16 1C8	Square Wave Generator	1. Set VOLTS/IN switch in positions indicated, then make capacitor adjustments described in steps 2 and 3 below: .1 - 1C1 2 - 1C24 .2 - 1C12 5 - 1C32 .5 - 1C20 10 - 1C16 1 - 1C28 20 - 1C8 2. For each setting of VOLTS/IN switch, adjust square wave generator output for one-inch deflection. 3. Adjust applicable capacitor indicated in step 1 above for true reproduction of square wave.
5*	Test Lead MX-2681/UP Adjustments 6C3 (10:1) 6C1 (100:1)	Square Wave Generator	1. Set VOLTS/IN switch to .05. 2. Connect video probe cable connector to VIDEO connector on Display unit. 3. Apply video probe tip to output connector of square wave generator. 4. Set probe attenuator control to 10:1. 5. Set square wave generator for 1000 Hz, 0.5 volt peak output. 6. Remove white button on probe body and adjust 6C3 for true reproduction of square wave. 7. Set probe attenuator to 100:1. 8. Increase generator output to 5 volts. 9. Adjust 6C1 for one-inch vertical deflection by removing the probe tip and using an Allen wrench.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
			DISPLAY UNIT (Cont.)
6*	Input Attenuator Equalizing 1C61 1C9 1C17 1C25 1C29 1C21 1C13 1C5	Square Wave Generator	1. Set VOLTS/IN switch to positions indicated, then make capacitor adjustments described in steps 2 through 5 below: .1 - 1C61 2 - 1C21 .2 - 1C9 5 - 1C29 .5 - 1C17 10 - 1C13 1 - 1C25 20 - 1C5 2. Leave video probe connected between VIDEO connector and square wave generator. 3. Set probe attenuator to 10:1. 4. Adjust square wave generator output for one-inch deflection. 5. For each setting of the VOLTS/IN switch, adjust applicable capacitor indicated in step 1 above for true reproduction of square wave.
			SWEEP AND INTENSITY MARK UNIT
7	SWEEP AMP (2R33)	Oscilloscope	1. Connect VIDEO input to pin 9 of 2V6. 2. Set SWEEP SPEED RANGE switch to 200-2000. 3. Turn SWEEP SPEED ADJUST control to mid-range. 4. Adjust 2R33 for 110 volt sweep amplitude.
8*	OSC FEEDBACK ADJ (2R50) 1 μsec Adjustment (2L2)	Oscilloscope	1. Set INTENSITY MARKS RANGE to 1, and INTENSITY MARKS LEVEL fully cw. 2. Set SWEEP SPEED RANGE to 200-2000. 3. Connect oscilloscope input 1 to pin 5 of 2J2. 4. Adjust oscilloscope to observe intensity gate pulse with superimposed 1-microsecond intensity markers. 5. Adjust PRF and SWEEP SPEED ADJUST so that intensity gate pulse duration is 1200 microseconds. 6. Turn 2R50 fully ccw, then slowly turn it cw until intensity markers appear on entire intensity gate pulse. 7. Connect oscilloscope input 2 to pin 3 of 3V2 in Crystal Mark and Sync unit. 8. Set SYNC SELECT switch to INT 1.00. 9. Adjust oscilloscope sweep speed control for 1 microsecond per 2 cm. Adjust oscilloscope delay time control for delay range of 0 to 1000 μsec. 10. Note any time difference between crystal markers and intensity markers. Begin turning oscilloscope sweep delay adjustment out to approximately 1000 microseconds. If a time difference between the crystal markers and intensity markers becomes apparent, adjust 2L2 to obtain zero time difference between both sets of markers.** Continue turning oscilloscope time delay out to 1000 μsec. At 1000 μsec time, difference between both sets of markers should be less than 2 μsec.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		SWEEP AND INTENSITY MARK UNIT (Cont.)	
			11. If intensity markers disappear before 1000 μsec delay is reached, turn 2R50 slowly cw until intensity markers appear and continue for approximately an additional 10 degrees; repeat step 10. 12. Disconnect pin 3 of 3V2 from oscilloscope input 2.
9*	0.1 μsec Adjustment (2T3)	Oscilloscope	1. Connect oscilloscope to pin 6 of 2V10. 2. Set INTENSITY MARK RANGE to .1. 3. Set oscilloscope sweep time for 1 μsec per 10 cm. 4. Adjust 2T3 for maximum amplitude of one .1 μsec marker for each cm on the oscilloscope.
10*	5 μsec Adjustment (2R73)	Oscilloscope	1. Calibrate oscilloscope for 1 μsec per cm. 2. Set INTENSITY MARKS RANGE control to .5. 3. Adjust 2R73 until one 5 μsec intensity marker coincides with each 5 cm graduation on the oscilloscope.
11*	50 μsec Adjustment (2R86)	Oscilloscope	1. Calibrate the oscilloscope for 10 μsec per cm. 2. Set INTENSITY MARKS RANGE to 50. 3. Adjust 2R86 until there is one 50 μsec intensity marker for each 5 cm graduation over a range of 1000 microseconds.
		CRYSTAL MARK AND SYNC UNIT	
12	PRF ADJ (3R40)	Counting Type Frequency Meter	1. Set SYNC SELECT switch to INT. 2. Connect frequency meter input to 0 TRIGGERS connector. 3. Turn PRF control on the Crystal Mark and Sync unit fully cw. 4. Adjust 3R40 for a frequency indication slightly over 4100 pps. 5. Set PRF control fully ccw. Frequency meter indication should be 15 cps or less; if not, readjust 3R40 and repeat step 4.
13	SWEEP DELAY ADJ (3C44)	Oscilloscope (Dual Trace)	1. Set SWEEP DELAY RANGE switch to 11-21. 2. Set SWEEP DELAY FINE control fully cw. 3. Connect oscilloscope input 1 to pin 8 of 3V11. 4. Connect oscilloscope input 2 to 0 TRIGGERS connector. 5. Adjust 3C44 for 21 μsec delay.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		SIF CODER	
14	Pulse Position Adjustment ST (4L10) C1 (4L11) A1 (4L12) C2 (4L13) A2 (4L14) C4 (4L15) A4 (4L16) X (4L17) B1 (4L18) D1 (4L19) B2 (4L20) D2 (4L21) B4 (4L22) D4 (4L23) SP (4L24) EM (4L25) ID (4L26)	None	1. Set PULSE WIDTH control to .45. 2. Set AMPLITUDE control fully cw. 3. Connect TRIGGER INPUT connector on SIF Coder to DELAYED TRIGGER connector on Crystal Mark and Sync unit. 4. Connect VARI OUTPUT connector on SIF Coder to VIDEO on Display unit. 5. Set INTENSITY MARKS RANGE to 1. 6. Set SWEEP SPEED RANGE to 1-30. 7. Set SWEEP SPEED ADJUST so that four intensity markers appear on trace. 8. Set VOLTS/IN and VIDEO SENS controls for one-inch pulse height. 9. Adjust 4L10 so that ST (Start) pulse appears 3 to 4 μsec after input trigger pulse. 10. Set SYNC SELECT switch to INT 1.45. 11. Adjust XTAL MARK LEVEL for visible markers. 12. Set FUNCTION selector to X. 13. Set four CODE selectors to 7777. 14. Adjust TRIGGER DELAY controls for coincidence of ST pulse and 1.45 μsec marker. 15. Adjust 4L11 to bring leading edge of the C1 pulse into coincidence with the next marker. 16. Adjust 4L12 through 4L24 so that the leading edge of each successive pulse in the train is coincident with its corresponding 1.45 μsec marker. 17. Set FUNCTION selector to EMER and align SP ("stop") pulse with a 1.45 μsec marker. 18. Adjust 4L25 so that ST pulse of the following pulse train is spaced 4.35 μsec (or 3 markers) from SP pulse of the preceding train. 19. Turn FUNCTION selector to ID and again align SP pulse with 1.45 μsec marker. 20. Adjust 4L26 so that ID pulse is spaced 4.35 μsec (or 3 markers) from SP pulse.
15	PULSE WIDTH ADJ (4R47) SUB PULSE WIDTH (4R32)	None	1. Set FUNCTION selector to N. 2. Set INTENSITY MARKS RANGE switch to .1. 3. Set SWEEP SPEED RANGE switch to 1-30 and adjust SWEEP SPEED ADJUST control so that C1 pulse occupies most of display. 4. Set INTENSITY MARKS LEVEL control for visible markers. 5. Set the PULSE WIDTH control fully ccw. 6. Adjust 4R47 for 0.3 μsec pulse. 7. Set PULSE WIDTH control fully cw. Pulse width should now be over 1 μsec.

Table 5-4. Radar Test Set TS-1253A/UP, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		SIF CODER (Cont.)	
15 (Cont.)			8. Adjust PULSE WIDTH control for 0.45 μsec pulse, loosen knob, set indicator at .45, and tighten knob. Note exact position of C1 pulse. 9. Turn SUB PULSE SELECT switch to C1. 10. Adjust 4R32 for 0.45 μsec width of the substituted C1 pulse.
16	SUB PULSE POS (4R141) SUB PULSE Delay Line (4DL1)	Oscilloscope	1. Leave controls as in step 10 above. 2. Set 4R141 to center position. 3. Set pickoff coil on 4DL1 (approximate center) so that sub pulse falls in exact coincidence with C1 pulse. 4. Set SUB PULSE POS control to 0 and tighten the two larger Allen head setscrews. If a slight readjustment of the sub pulse position is required after setscrews have been tightened, loosen LINE LOCK screw on rear end of delay line, adjust the core and readjust until the two pulses fall in exact coincidence. 5. Repeat step 4 for minimum shift between substitute pulses and the pulses to be replaced. 6. Set the SUB PULSE POS knob to detented positions and tighten small setscrews on knob.

*These adjustments must be performed in sequence as presented.
**The 1-mHz oscillator tank circuit is located in a temperature controlled oven. The oven cover must be removed before adjustment of 2L2 can be made. This is done by loosening the retaining strap, pulling the oven assembly out of its socket, removing the cover, and reinserting the oven assembly without the cover into its socket. Allow at least ten minutes warmup time before making adjustments.

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
1	+300 V ADJ (8R35)	Voltmeter	1. Connect positive lead of voltmeter to +300 V test point TP3; negative lead to chassis. 2. Adjust 8R35 for +300 volts.
		CALIBRATION-CONTROL UNIT	
2	WM ADJ (9R61)	None	1. Set METER SELECT to WM. 2. With no signal input to wavemeter, adjust WM ADJ 9R61 for full scale meter deflection.
3	ALC ADJ (9R3)	RF Power Meter	1. Set ATTENUATION dial to 021.0. 2. Connect rf power meter to SG OUT receptacle. 3. Provide a modulation signal for the rf signal generator. 4. Tune signal generator to approximately 1050 mHz. Adjust 9R3 until the rf power meter indicates -8.3 dbm.

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		CALIBRATION-CONTROL UNIT (Cont.)	
4	CAL ADJ (9R36)	Oscilloscope	1. Set METER SELECT switch to CAL. 2. Set VIDEO OUT switch to 10. 3. Set TRIGGER switch to INT. 4. Connect oscilloscope input to VIDEO OUT connection. 5. Adjust external CAL ADJ control for full scale deflection on meter. 6. Adjust oscilloscope for a convenient display of the pulse. 7. Adjust 9R36 until the pulse height (measured on the oscilloscope) is 10 volts. 8. Turn VIDEO OUT switch to 50 and check that pulse height is 50 volts and that meter reads full scale. A slight readjustment of 9R36 and the external CAL ADJ control may be necessary.
5	PRF 0-500 (9R30)	Frequency Counter	1. Set TRIGGER switch to INT. 2. Set METER SELECT switch to 500 PRF. 3. Connect the counter to the 0 TRIGGER connector on the Crystal Mark and Sync unit. 4. Adjust the PRF control until the counter indicates 500. 5. Adjust 9R30 until meter indicates 500.
6	PRF 0-5000 (9R31)	Frequency Counter	1. Set METER SELECT switch to 5000 PRF. 2. Adjust the PRF control until the counter indicates 4000. 3. Adjust 9R31 until meter indicates 4000.
7	SHAPE ADJ (9C26)	Square Wave Generator Oscilloscope	1. Connect generator output to 9P4 of the Calibration-Control unit. 2. Connect input 1 of the oscilloscope to the generator output. 3. Connect input 2 of the oscilloscope to VIDEO OUT connector on the Calibration-Control unit. 4. Set VIDEO OUT switch to SHAPE position. 5. Adjust generator frequency to about 1000 Hz. 6. Adjust generator amplitude to about 1 volt. 7. Observing the two square wave traces on the oscilloscope, adjust 9C26 for best matching of both forms.
8	Mode 4 Decode Pulse AMPL. (9A4R27)	None	1. Hook up AN/UPM-98A as in figure 2-3A to obtain simulated Mode 4 reply. Perform Mode 4 Reply Decoding 2-8c(2)(b), steps 1 through 11. 2. Hook up AN/UPM-98A as in figure 2-3B to inject signal into decoder, and perform steps 12 through 14 of 2-8c(2)(b). 3. If amplitude of output pulse is more than 5 volts or less than 2 volts, adjust MODE 4 AMPL potentiometer 9A4R27 for an output of 4 volts.

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		CALIBRATION-CONTROL UNIT (Cont.)	
9	Mode 4 Decode PULSE WIDTH (9A4R25)	None	1. Perform same procedure as in steps 1 and 2 of adjustment number 8 above. 2. If width of output pulse is outside the tolerance limits of 0.5 ±0.1 μsec, adjust MODE 4 PULSE WIDTH potentiometer for an output pulse width of 0.5 μsec.
		INTERROGATION CODER	
10	+25 V ADJ (12R24)	Multimeter AN/PSM-4	1. Connect positive lead of voltmeter to +25 V test point 12TP4, negative lead to chassis. 2. Adjust 12R24 for +25 volts.
11	+12 V ADJ (12R32)	Multimeter AN/PSM-4	1. Connect positive lead of voltmeter to +12 V test point 12TP3, negative lead to chassis. 2. Adjust 12R32 for +12 volts.
12	12A1R8 (Selected Resistor normally 39 ohms)	Oscilloscope AN/USM-105A	Connect oscilloscope to TP4. If pulse width is not 0.95 to 1.1 μsec, select a value for 12A1R8 which will give a pulse within above limits.
13	Clock Timing ADJ (12A1C8)	Oscilloscope AN/USM-105A	Connect oscilloscope to Clock Output test point 12A1TP1 and adjust 12A1C8 for pulses spaced 1 microsecond apart.
14	12A1R36 (Selected Resistor normally 470 ohms)	Oscilloscope AN/USM-105A	Connect oscilloscope to TP2. If pulse width is not 0.95 to 1.1 μsec, select a value for R36 which will give a pulse within above limits.
15	RF OSCILLATOR ADJ 12A5C5 12A5C9 12A5C12 12A5C19 12A5C22 12A5C23 12A5C24 12A5C25 12A5C26 12A5C28 12A5C29 12A5C32 12A5C33 12A5Z1		CAUTION Do not attempt the following adjustments of the RF Oscillator 12A5 unless it has definitely been determined that the circuits are out of alignment. Careless turning of any of the adjustment screws may make a lengthy alignment procedure necessary. 1. Remove upper side cover from subassembly 12A5 by removing 5 screws. 2. Connect servicing cable CG-3380/U from connector 12J11 on Interrogation Coder to LP IN on SM-197A/UPM-98. Connect cable from VIDEO OUT on Calibration-Control unit to VIDEO input on Display. Set VIDEO OUT switch on Cal-Control unit to DEMOD POWER to observe demodulated rf pulse. 3. Place POWER switch on SM-197A/UPM-98 in the ON position and connect a video cable from the TRIG connector on the Interrogation Coder to the DELAYED TRIGGERS connector on the Crystal Mark and Sync unit. 4. Set Function Selector on Interrogation Coder to TEST. 5. Set Mode Selector on Interrogation Coder to 2. 6. Adjust Crystal Mark and Sync unit for a prf of 1000 pps.

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		INTERROGATION CODER (Cont.)	
15	RF OSCILLATOR ADJ (Cont.)		7. Set ISLS Selector to 2 μsec. 8. Turn ISLS Level control and CAL adjustment maximum cw and measure output power on Calibration-Control unit. Power should be 10 watts minimum. 9. If output is less than 10 watts, align oscillator output circuit and buffer stage to the crystal frequency by carefully touching up 12A5Z1, 12A5C5, 12A5C9, 12A5C12, 12A5C19, 12A5C22, 12A5C23, 12A5C24, 12A5C25, 12A5C26, 12A5C28, 12A5C29, 12A5C32, 12A5C33, and repeat 12A5Z1 for maximum output. Use an insulated alignment tool for this adjustment. If no output or a very low output is seen in step 8 above, proceed with adjustment 16 below.
16	RF Oscillator Adjustments to correct for low output power. 12A5C5 12A5C9 12A5C12 12A5C19 12A5C22 12A5C23 12A5C24 12A5C25 12A5C26 12A5C28 12A5C29 12A5C32 12A5C33 12A5Z1	Oscilloscope AN/USM-105A, (with special probe adapter, figure 5-2) RF Signal Generator AN/UPM-41A	1. Inductively couple the special oscilloscope probe to 12A5L6. 2. Carefully adjust 12A5C5, 12A5C9, 12A5C12, 12A5C19, 12A5C22, 12A5C23, 12A5C24, and 12A5C25 for maximum output, taking care not to adjust the doubler and tripler to the incorrect harmonic. 3. Check for correct frequency by loosely coupling signal generator output into 12A5L6 and varying the frequency between 343 mHz and 687 mHz. A distinct "zero beat" should be seen on the oscilloscope at 515 mHz. 4. Remove the special oscilloscope probe from 12A5L6. 5. Check output power as in step 2 and adjust 12A5C25, 12A5C28, 12A5C29, 12A5C26, 12A5C32, 12A5C33, and cavity 12A5Z1 for maximum power out.
17	RF Oscillator Adjustments to correct frequency. 12A5Z1 12A5C5 12A5C9 12A5C12 12A5C19 12A5C22 12A5C23 12A5C24 12A5C25 12A5C26 12A5C28 12A5C29 12A5C32 12A5C33	Oscilloscope AN/USM-105A	1. Set WAVEMETER INPUT to DEMOD. 2. Set METER SELECT to WM. 3. Using WAVEMETER FREQUENCY control, check that output of rf subassembly is 1030 ±0.7 mHz. If it is not, repeat adjustment 15, step 9. 4. Turn off power. Remove test cables. Replace cover on rf subassembly.

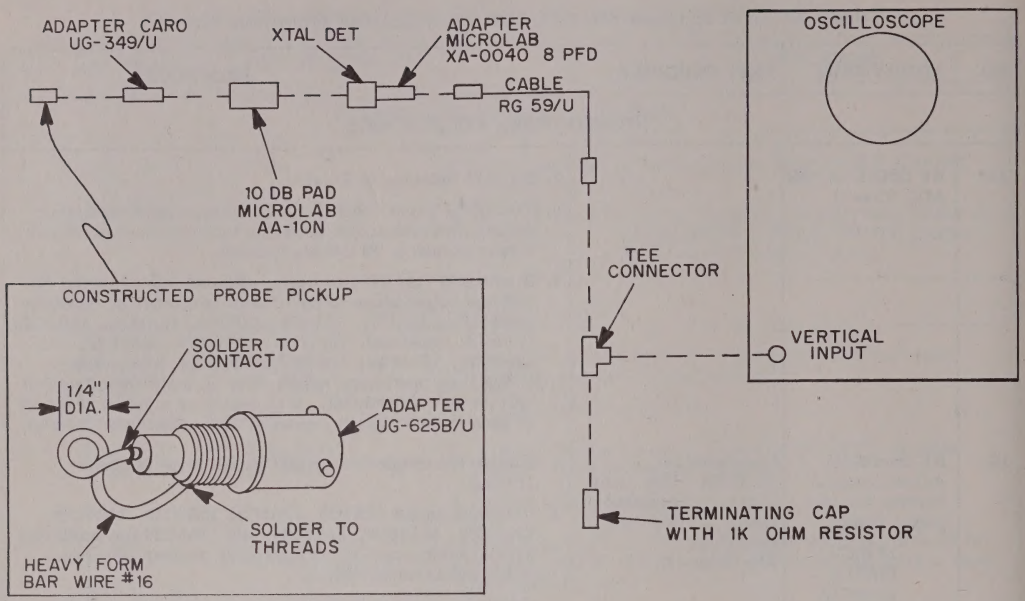


Figure 5-2. Special Probe Adapter for Alignment of RF (ISLS) Subassembly 12A5

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		INTERROGATION CODER (Cont.)	
18	ISLS CAL (Balance) Adjustment (12R9)	None	1. Connect CODER OUT connector on Interrogation Coder to VIDEO connector on Display unit. 2. Turn Interrogation Coder Function Selector to (+). 3. Turn ISLS Level control fully clockwise. Using CAL adjust, set ISLS level on Display oscilloscope so that ISLS pulse amplitude is about 1-1/2 db above that of the interrogation pulse. 4. Turn ISLS Level control slowly counterclockwise. When pulse amplitudes are equal, loosen knob setscrew, set knob pointer to 0 index mark, and tighten setscrew. 5. Continue turning knob counterclockwise. When ISLS pulse level is 9 db below the interrogation pulse, loosen set-screw on index disk and rotate until -9 db index mark is under knob pointer. Tighten setscrew on index disk.

Table 5-5. Coder Simulator SM-197A/UPM-98, Adjustment Procedures (Cont.)

NO.	ADJUSTMENT	TEST EQUIPMENT	PROCEDURE
		INTERROGATION CODER (Cont.)	
19	ISLS 2 μsec ADJ (12A6R11)	Oscilloscope AN/USM-105A	1. Connect oscilloscope to CODER OUT connector on Interrogation Coder. 2. Set Interrogation Coder and oscilloscope controls to display Mode 3/A interrogation with 2 μsec ISLS pulse. 3. Adjust 12A6R11 so that ISLS pulse (P2) follows first interrogation pulse (P1) by 2 microseconds.
20	40 μsec ADJ (12A6R21) 12A6R30 (Selected Resistor, normally 39 ohms)	Oscilloscope AN/USM-105A	1. Connect oscilloscope so that its sweep is started by the same pulse which triggers the Interrogation Coder. 2. Connect the OUT connector on the Interrogation Coder to the oscilloscope input. 3. Adjust 12A6R21 so that the trigger from the OUT connector follows the input trigger by 40 microseconds. If the trigger pulse width is not 1 $\pm$0.1 μsec, select a value for 12A6R30 to give a width within these limits.
21	TAG AMPL. ADJ (12A6R69)	None	1. Connect SIF coder MOD DRIVE connector to MOD (modulation) connector on Interrogation Coder. 2. Connect Interrogation Coder OUT (40 μsec delayed trigger) connector to TRIGGER INPUT connector on SIF Coder. 3. Connect display unit VIDEO input to Interrogation Coder CODER OUT connector. 4. Set Function Selector on Interrogation Coder to MOD-MIX position. 5. Set VIDEO selector on Interrogation Coder to RESET position. 6. Set SWEEP SPEED ADJUST control on Sweep and Intensity Mark unit to show the three reset tag pulses. 7. Set LEVEL switch on SIF Coder to HI position and CODE selectors to 7777. 8. Set VIDEO selector on Interrogation Coder to BOTH position. Note that the SIF reply pulse train is followed by three reset pulses. 9. Set VIDEO LEVEL control fully cw and check reset pulse amplitude. If amplitude is not 5 volts, adjust 12A6R69 for an amplitude of 5 volts. Leave equipment set for next test.
22	21 μsec DELAY ADJ (12A6R76)	None	1. With equipment controls set as step 9 above, check spacing between leading edge of last pulse in reply pulse train and leading edge of first reset pulse. 2. If spacing is not within 20 $\pm$2 μsec, adjust 12A6R76 for a spacing of 21 μsec.

5-4. REMOVAL AND REASSEMBLY OF PARTS AND SUBASSEMBLIES.

a. GENERAL. - This section contains instructions for repair and replacement of parts. Repair instructions which are obvious and instructions for parts which cannot be economically repaired by normal maintenance techniques are not included. Such parts shall be replaced as higher subassemblies as listed in Section 6, Parts List.

The procedure for removal of most subassemblies and parts in the radar test set is obvious and does not require special detailed instructions. Removal of parts should be done carefully in order to prevent damage not only to the parts involved, but also to adjacent parts. Be especially careful of tubes, and in particular, the cathode ray tube in the Display unit. When unsoldering wires from parts, make a note of the location of the wires and other affected parts, especially if a similar unit is not available for comparison of lead dress and parts location. This is particularly important when unsoldering and removing parts which have numerous wires connected to them, such as multi-gang switches.

(1) CHASSIS-MOUNTED TERMINAL STUDS. - Most of the small parts in the test units, such as resistors, capacitors, diodes, etc., are mounted on small chassis-mounted terminal studs. Any broken or damaged standoff or feedthru terminal studs must be replaced. They can be removed from the chassis by pressing on the teflon insulator part with a suitable blunt instrument. To install the teflon insulated terminal studs, use a short length of metal rod, approximately 1/4 inch in diameter with a 3/8-inch deep, 3/16-inch diameter hole in its end. Use this rod to press the teflon insulating part of the stud into the hole in the chassis. These terminals can be damaged or broken when attempting to remove soldered wires from them. When removing wires from the terminals, heat the soldered joint, and carefully unwrap the wire from the stud with long nosed pliers or with a tool designed especially for this purpose. Also exercise care when wrapping new leads around the terminal studs.

(2) SEMICONDUCTOR DIODES. - When replacing semiconductor (crystal) diodes, be careful to connect the replacements into the circuitry in the same polarity as the old ones. The cathode end of the diode is usually marked with a bar, a "-" sign, or a "k" letter. On the chassis, the connection point for the anode of a semiconductor diode usually is marked with a "+" sign. When soldering semiconductor diodes into the circuit, leave sufficient lead length to permit handling and hold the lead with a pair of pliers between the body and the wire end to be soldered so that heat will not be conducted through the wire lead to the diode element.

(3) MECHANICAL PARTS. - If an inspection performed in accordance with instructions in this technical manual reveals the need for replacement of any mechanical parts in Radar Test Set AN/UPM-98A, refer to the removal instructions given here. Replacement and adjustment of the new parts is described in later paragraphs.

b. REMOVAL OF MAJOR UNITS.

(1) RADAR TEST SET TS-1253A/UP.

(a) Loosen the five large captive screws around the front panel holding the drawer to the case.

(b) Withdraw the drawer partially from the case so that interunit cable connection 5J1(7P2) located at the right-hand side of the drawer can be seen.

(c) Disconnect the interunit cable plug 7P2 by disengaging the two fastening springs on the sides of it.

(d) Pull the panel-chassis out until it is stopped by the two safety devices on the sides of the chassis.

(e) Disengage the safety holders by depressing the levers, and remove the panel-chassis from the case. Because of the weight of the unit, two men should perform the task of removing it from the case.

(f) To replace the panel-chassis, reverse the removal procedure.

(2) CODER SIMULATOR SM-197A/UPM-98. - Remove the coder simulator from the equipment case in the same manner as the TS-1253A/UP, except be sure to disconnect 7P3 from 8J21 when removing the chassis. Because of the weight of the unit, two men should lift it from the case.

c. REMOVAL AND REPLACEMENT OF TS-1253A PLUG-IN UNITS.

(1) REMOVAL. - To remove the TS-1253A plug-in units, proceed as follows:

(a) Loosen and turn the four fasteners (bridge clamps) holding the plug-in unit front panels to the panel-chassis assembly.

(b) Pull each unit out by the handle on the bottom of the front panel. When removing the Sweep and Intensity Mark unit, use care to avoid damaging connector 2J2 at the left side rear.

(2) REPLACEMENT. - To install the four plug-in units into the panel-chassis of Radar Test Set TS-1253A/UP, insert each unit into the proper cutout in the front panel of the panel-chassis, push gently into position, and tighten the wing-type fasteners.

CAUTION

If a unit will not go into place with only moderate effort, do not attempt to force it in, because the "blue ribbon" type connectors may be damaged, necessitating complicated repairs. In such cases, loosen the two nuts on the locating pins for the plug-in unit. (The nuts are accessible from the bottom of the panel-chassis). Carefully insert the plug-in unit so that its blue plug mates with its connector without binding, then re-tighten the nuts on the locating pins.

d. REMOVAL AND REPLACEMENT OF SM-197A PLUG-IN UNITS.

(1) REMOVAL OF CALIBRATION-CONTROL UNIT. - Turn four bridge clamps that hold the front panel of the plug-in unit. Pull unit from panel-chassis assembly with handle at front of unit.

(2) REMOVAL OF INTERROGATION CODER. - Removal procedures for this unit are the same as for the Calibration-Control unit described above.

(3) REPLACEMENT OF PLUG-IN UNITS. Replace the Calibration-Control unit and the Interrogation Coder by reversing the removal processes.

e. DISASSEMBLY OF TS-1253A PLUG-IN UNITS.

(1) DISPLAY UNIT.

(a) REMOVAL OF CATHODE-RAY TUBE 1V7.

Step 1. Remove the 12-pin tube socket 1XV7 from the end of the CRT and detach the five wires with clip contacts from the neck of the CRT. Also, disconnect high voltage connector from side of tube.

Step 2. Remove clamp holding socket end of CRT by unscrewing two machine screws.

Step 3. Remove two machine screws holding CRT neck shield to mounting bracket on chassis.

Step 4. Remove CRT and shield from the unit by lifting up.

(b) INSTALLATION OF CATHODE-RAY TUBE.

Step 1. Place Display unit on workbench with front panel down.

Step 2. Place gasket (Admiral Part No. 512B159) in the cutout on rear of the front panel).

Step 3. Place on top of gasket installed in step 2 CRT scale (Admiral Part No. 521C18-1), CRT light filter (Admiral Part No. 521C18-2), and bumper gasket (Admiral Part No. 512B160), in that order.

Step 4. Apply a small amount of Glyptol to one side of a strip of rubber (Admiral Part No. 512B18-56) and place it on center of the edge of bumper gasket in front of scale light 1DS1.

Step 5. Slip cathode-ray tube into shield assembly so that the contacts on the neck appear in the cutout on the neck shield.

Step 6. Place face of the CRT on the bumper gasket so that high voltage connector is on the left hand side and rubber strip installed in step 4 is located between edge of cutout on front panel and side of CRT.

Step 7. Fasten the ears of the CRT neck shield to mounting bracket with two machine screws and markers, so that the face of the CRT is centered and pushed flat against the bumper gasket.

Step 8. Apply Glyptol to one edge of three more rubber strips (Admiral Part No. 512B18-56) and glue them to the bumper gasket by pushing down between sides of CRT and front panel at square cutouts provided on three sides of CRT shield.

Step 9. Route wire with the rubber-capped high voltage connector between CRT and its shield so it reaches contact A1 on the side of CRT. Lift and "jiggle" CRT shield to facilitate passage of the rubber cap.

Step 10. Connect the five wires with electrical clips to contacts on neck of CRT as follows:

White-blue wire from 1J3 to D2
White-green-blue wire from 1J3 to D1
White-orange wire to A2
White-blue wire to D3
White-green-blue wire to D4

(c) REMOVAL OF ATTENUATOR ASSEMBLY. - To remove the attenuator assembly (including VOLTS/IN switch 1S2) proceed as follows:

Step 1. Unsolder attenuator wires from center of VIDEO connector 1J1 and pin 2 of 1XV2.

Step 2. Loosen two setscrews inside the chassis attaching the flexible shaft of VIDEO SENS control 1R41 to attenuator. Remove center shaft from attenuator by pulling it out with VIDEO SENS knob.

Step 3. Remove 1S2 mounting nut and lockwasher from front of front plate.

Step 4. Remove tubes 1V1 and 1V2 with their shields. The attenuator assembly now is free to be lifted out.

(d) INSTALLATION OF ATTENUATOR ASSEMBLY. - The procedure for reinstallation of attenuator assembly is the reverse of removal as described above.

NOTE

When installing VIDEO SENS shaft through attenuator assembly, make certain that the groove on stop cam of variable resistor 1R41 engages the stop spring when resistor shaft is in the extreme clockwise position, then install VIDEO SENS knob with the white marker pointing to front panel screening position marked CAL.

(2) CRYSTAL MARK AND SYNC UNIT.

(a) DELAY LINES 3DL2 AND 3DL3.

1. REMOVAL.

Step 1. Unsolder all wires connected to the delay line assembly, taking note of the connections so that the new or repaired delay line

assembly will be wired correctly.

Step 2. Remove knob by loosening Allen setscrew.

Step 3. Pull off the calibrated dial. Note positions of three small planetary gears, internal tooth gear on calibrated shaft, and small central gear which is part of the shaft.

Step 4. Remove three sets of screws, plain washers and plastic washers on which the three planetary gears are mounted. Front end of delay line is now free of front panel.

Step 5. Remove the two screws and lockwashers holding the rear end of the delay line to the chassis frame. The delay line is now free to be removed.

2. DISASSEMBLY.

Step 1. Loosen and remove screw and lockwasher adjacent to the LINE LOCK label.

Step 2. Carefully pull delay line core from delay line assembly. Do not damage wire leads.

Step 3. Remove three remaining sets of screws and lockwashers from rear end of delay line assembly.

Step 4. Remove two screws, one crimped solder lug, two flat washers, and two fiber bushings from helical slot on delay line assembly.

Step 5. Pull pickoff coil, bobbin, and loading spring out of inner cylinder.

3. REASSEMBLY

Step 1. Place bobbins on pickoff coils with loading spring locked between them in the holes provided for this purpose. See figure 5-3A.

Step 2. Secure pickoff coil and bobbin as shown in figure 5-3B. Fabricate the assembly aid from a length of No. 14 steel wire in accordance with figure 5-1.

Step 3. Push pickoff coil leads through the helical slot in the inner cylinder.

Step 4. Insert pickoff coil, bobbin, and assembly aid into inner cylinder, and align threaded holes on pickoff coil and bobbin with helical slot in inner cylinder.

Step 5. Attach two sets of screws, flat washers, and tubing into threaded holes as shown in figure 5-3C. A solder lug is used to secure pickoff coil lead previously fed through helical slot.

Step 6. Remove assembly aid.

Step 7. Replace end cap, attaching screws, and lockwashers. The longest screw is used in the hole adjacent to the LINE LOCK label. Do not tighten this screw at this time.

Step 8. Loop solder lug around pickoff coil lead, but do not crush lead.

Step 9. Lock lead in place with "C" spring. Be sure two tabs on "C" spring fit into two holes on assembly provided for this purpose. See figure 5-3C.

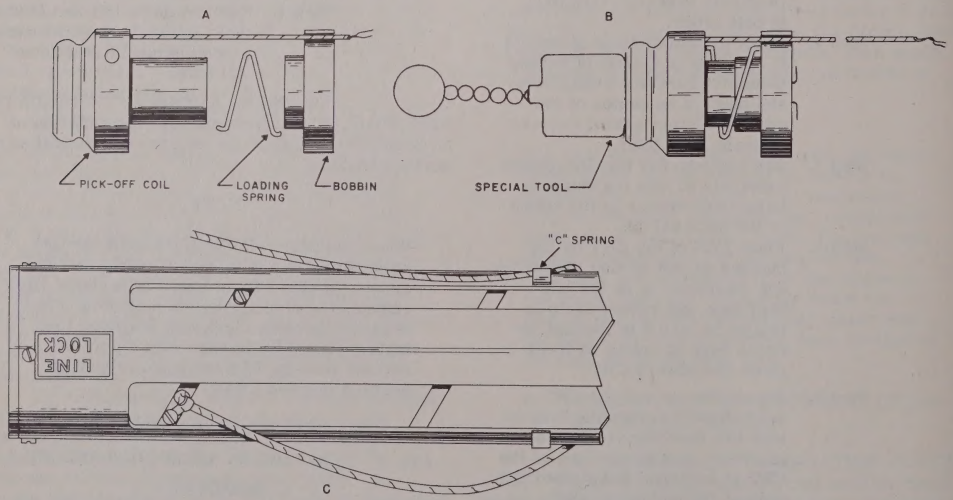


Figure 5-3. Reassembly of Delay Line Pickoff Coils

Step 10. Turn delay line shaft from stop to stop and check for binding, excessive looseness, and wire lead jamming.

Step 11. Apply a thin coat of molybdenum disulphide (Molycote type Z, by Alpha Corp., Greenwich, Connecticut); Admiral Part No. 551B7-16 to the surface of the delay line.

Step 12. Insert delay line into assembly. Use a slight "wiggling" motion so that delay line will seat at panel end of assembly. Tighten LINE LOCK screw until delay line is held firmly in place, but do not tighten down all the way. The delay line will be positioned electrically in another procedure.

4. INSTALLATION.

Step 1. Set delay line assembly in place in the unit, and attach to the front panel with three fillister head screws.

Step 2. Secure rear end of delay line assembly with two screws and lockwashers provided for this purpose.

Step 3. Solder delay line and pickoff coil leads to correct terminals. If necessary, refer to the schematic diagram for the unit.

Step 4. Place three flat washers and plastic washers over the heads of the screws installed in step 1. Place the three planetary gears on top of the washers.

Step 5. Turn the delay line assembly shaft fully ccw, and set the calibrated dial on the panel so that it meshes with the planetary gears, and figure 1 on the dial is aligned with the index mark on the panel.

Step 6. Set the knob on the shaft, and tighten the setscrew. Turn the knob from stop to stop and check that there is no irregular movement of the control.

5. ADJUSTMENT.

Step 1. Connect the Crystal Mark and Sync unit to the power supply in the panel-chassis assembly using the 24-pin servicing cable CX-4963/UPM.

Step 2. Set the operating controls on the front panel of the TS-1253A/UP to the preliminary control positions shown in table 2-1, then start the equipment.

NOTE

The following steps 3 thru 7 apply to adjustment of trigger delay line 3DL2. For adjustment of sweep delay line 3DL3, use DELAY STROBE SWEEP, SWEEP DELAY RANGE, and SWEEP DELAY FINE controls instead of the trigger controls.

Step 3. Set TRIGGER DELAY RANGE switch to 1-11 and TRIGGER DELAY FINE control to 1.

Step 4. Set INTENSITY MARKS RANGE to 1 and adjust INTENSITY MARKS LEVEL control for presence of one-microsecond intensity markers.

Step 5. Depress and hold down DELAY STROBE TRIGGER switch and note the position of delayed trigger. It should be coincident with the first intensity marker after the start of the sweep.

Step 6. If the delayed trigger is not spaced exactly 1 μsec from the start of the sweep, loosen the LINE LOCK screw at the end of the delay line and move the core of the delay line until the delayed trigger appears in coincidence with the appropriate intensity marker.

Step 7. Tighten the LINE LOCK screw holding the core.

(3) SIF CODER.

(a) DELAY LINE 4DL1.

1. REMOVAL.

Step 1. Loosen but do not remove the two large and the five small Allen setscrews on the SUB PULSE POS knob (figure 5-4). Pull the knob from the shaft.

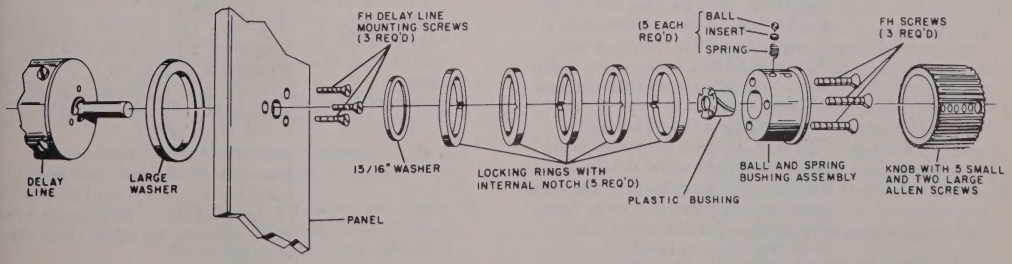


Figure 5-4. Delay Line Knob Detent Mechanism

Step 2. Remove three 6-32 flat-head machine screws holding the detent assembly. Pull assembly from shaft. Remove the 15/16-inch washer.

Step 3. If it is necessary to disassemble the detent assembly, proceed with step 4. If disassembly is not required, omit step 4 and proceed with step 5.

Step 4. Snap off the first of the five locking rings from the ball-and-spring bushing as shown in figure 5-4. Take care not to lose balls, plastic inserts, or springs. Remove remaining four locking rings in a similar manner.

Step 5. Unsolder the seven wires connecting the delay line and the pickoff coil into the circuitry.

Step 6. Remove delay line assembly DL501 from panel by unscrewing three remaining 6-32 flat-head machine screws.

2. DISASSEMBLY. - Disassembly of delay line 4DL1 is the same as the procedure for delay lines 3DL2 and 3DL3.

3. REASSEMBLY. - Reassembly of delay line 4DL1 is the same as steps 1 through 5 of the procedure for delay line 3DL2 and 3DL3.

4. INSTALLATION.

Step 1. To install delay line 4DL1 in the SIF Coder, place the 15/16-inch washer on the delay line shaft, insert the shaft through the hole in the front panel, and secure the delay line with three 6-32 flat-head screws.

Step 2. If the detent assembly has been disassembled, refer to figure 5-4 and replace parts in the following manner: insert five sets of springs and plastic inserts into five holes provided on the ball-and-spring bushing assembly. Place a ball in the hole nearest the end of the ball-and-spring bushing assembly with three countersunk screw holes, and press locking ring onto bushing so that notch on inner surface engages the ball. Replace the remaining balls in the same manner. It is important that notches on inner surface of locking rings engage their associated balls.

Step 3. Place 15/16-inch diameter washer on shaft and slide detent assembly onto shaft so that the three countersunk holes are away from the panel. Secure with three 6-32 flat-head screws.

Step 4. Slide knob over detent assembly, but do not tighten setscrews at this time.

5. ADJUSTMENT. - Adjustment of the core of delay line 4DL1 is dependent upon adjustment of the internal SUB PULSE POS control 4R141 and should be performed in conjunction with it (see step 16 of table 5-5).

f. DISASSEMBLY OF SM-197A/UPM-98 UNITS.

(1) CALIBRATION-CONTROL UNIT. - No detailed disassembly procedure is given for the Calibration-Control unit, since the method is obvious.

(2) INTERROGATION CODER. - No detailed disassembly procedure is given for the Interrogation Coder, since the method is obvious.

(3) REMOVAL AND REPLACEMENT OF 8V2, 8V3, and 8CR1. - The following procedures do not require that the support base plate be removed from the coder simulator chassis. Access to rf oscillator tube 8V2 is gained by unscrewing the cap on the rear of the assembly and unscrewing the tube mounting bushing. The tube now can be removed with a gentle twisting and pulling motion. Demodulator tube 8V3 is held to the assembly by two clamps. Loosen these clamps and remove the tube and socket together, then pull the tube from the socket. Wavemeter detector diode 8CR1 can be removed by first disconnecting 8P12 from the wavemeter assembly and then loosening the Allen setscrew which permits the diode holder to be unscrewed. The wavemeter detector diode can now be pulled from the socket. In each of the above cases replacement is the reverse of removal.

(4) RF PLUMBING ASSEMBLIES. - RF Oscillator Assembly 8A1, ALC/Attenuator Assembly 8A2, Wavemeter Assembly 8A3, wavemeter input switch 8S1, and the associated indicators and gears are mounted on a supporting base plate inside the coder simulator chassis. Access to the wavemeter or to the wavemeter input switch is possible only after the support base plate has been removed from the chassis. To remove the support base plate from the coder simulator chassis, proceed as follows:

Step 1. Remove SG FREQUENCY, WAVEMETER FREQUENCY, WAVEMETER INPUT, and ATTENUATION front panel knobs.

Step 2. Disconnect connectors 8P19 and 8P20 from the power supply, and 8P7 and 8P3 from the rf oscillator assembly.

Step 3. Unsolder ALC rectifier filament lead at 8C1 lug on the back of attenuator assembly.

Step 4. Remove four machine screws holding SG OUT connector 8J6 to the front panel.

Step 5. Remove four machine screws from the front panel and five machine screws from the bottom of the chassis. The support base plate can now be lifted from the chassis.

Step 6. To replace the base plate, reverse the removal process.

NOTE

Perform disassembly only to the extent necessary for maintenance and repair. Further disassembly of the individual rf assemblies may make recalibration of the assembly necessary.

(5) WAVEMETER INPUT SWITCH 8S1.

(a) To remove the wavemeter input switch 8S1 from the support base plate, proceed as follows:

Step 1. Disconnect 8P8, 8P9, and 8P10 from the wavemeter input switch.

Step 2. Loosen the two Allen setscrews from the spring-retaining collar and remove the spring-retaining collar and spring from the wavemeter input switch shaft.

Step 3. Remove the two machine screws that fasten the wavemeter input switch to the support base plate. The wavemeter input switch can now be pulled free from the rear of the support base plate.

(b) To replace the wavemeter input switch 8S1, proceed as follows:

Step 1. Place the spring in position on the wavemeter input switch shaft with one end inserted into the hole provided on the support base plate and the other fitted into the collar.

Step 2. Tighten the Allen setscrews so that the spring-retaining collar mounts securely to the wavemeter input switch shaft.

Step 3. Rotate the wavemeter input switch and spring-retaining collar clockwise so that the spring makes two and one-quarter turns around the wavemeter input switch shaft.

Step 4. Mount the wavemeter input switch to the support base plate with two machine screws and associated washers.

Step 5. Reconnect 8P8, 8P9, and 8P10 to the wavemeter input switch.

(6) RF OSCILLATOR ASSEMBLY 8A1.

(a) REMOVAL FROM BASE PLATE ASSEMBLY. - By loosening the two Allen head setscrews that hold the spur gear onto the center shaft, the spur gear can be removed. Loosen these two screws and remove the two screws and washers that attach the rear of the oscillator assembly to the base plate. Disconnect 8P3 (cable 8W7) from J3, and disconnect 8P4 (cable 8W1) from J4 on oscillator assembly.

(b) DISASSEMBLY. - To disassemble the rf oscillator (figure 5-5), proceed as follows:

Step 1. Unscrew and remove cap (item 1) and tube retaining ring (item 2) from top of oscillator tube 8V2 (item 3).

Step 2. Remove oscillator tube 8V2 by rocking slightly and pulling. If the tube is very tightly seated, use a rubber tube puller or wind a length of electrical insulating tape around top of the tube to provide a better grip.

Step 3. Unsolder wire (item 20) from terminal stud (item 9) on the plate contact ring (item 7).

Step 4. Loosen setscrew (item 18) and remove oscillator plate filter assembly 8Z1 (item 19) containing capacitors 8C5 and 8C6 (items 23 and 21), and wire coil 8L3 (item 58) inside spacer sleeve (item 22).

Step 5. Loosen setscrew and remove coupling and connector 8J4 assembly (item 24).

Step 6. Unscrew five black nylon screws (item 4), remove plate contact ring (item 7) and insulator ring (item 8).

Step 7. Remove five screws and washers (item 44) holding housing and cavity together.

Step 8. Hold housing in one hand so that the cavity (item 14) is pointing downward. With the other hand turn oscillator tuning shaft clockwise until the two parts disengage and separate.

Step 9. Unscrew plug screw with washer (item 26) and using an Allen head wrench, remove feedback probe (item 17).

Step 10. Using a pair of long-nose pliers, remove feedback contact (item 15) from the inner cavity by gently pulling it off.

Step 11. Remove feedback probe nylon bushing (item 16) from the wall of the larger cavity by pushing it out from inside.

Step 12. If cable assembly 8W9 (item 25) has not yet been removed, remove it by loosening its setscrew.

Step 13. Unscrew six contact rod nuts (item 38) with washers and remove lead screw (item 37) with backlash nut (item 39) and stop stud (item 36).

Step 14. Remove both cavity contact rings (items 10 and 11) by pushing out tuning rods (items 12 and 13) from rear of the housing with a suitable round tool. The tuning rods can be removed from contact rings by carefully unscrewing so as not to distort or damage the contact ring fingers.

Step 15. Remove three sets of three-prong contacts (item 33) by removing screws with washers (item 34).

Step 16. Unsolder the short length of wire (item 28) from terminal lug

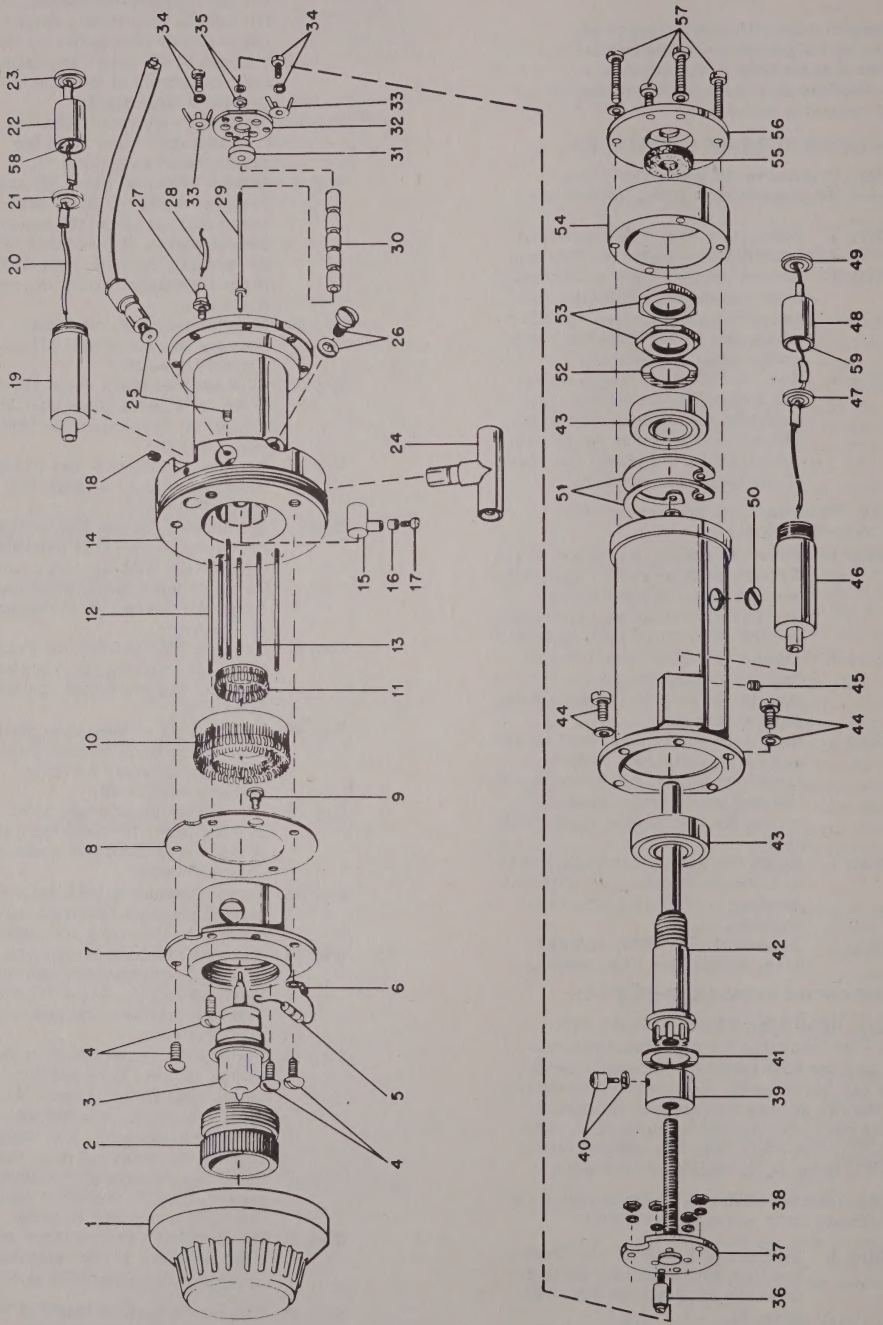


Figure 5-5. Oscillator Assembly 8A1, Exploded View

Table 5-6. RF Oscillator Assembly 8A1, Parts Identification

Call Out No. (Figure 5-5)	Description	Admiral Part/Dwg No.
1	Cap	P-20A30
2	Tube Retaining Ring	PA27A184
3	Electron tube (8V2)	2C36
4	Machine Screw (Nylon)	P-1A5
5	Resistor (8R40)	RC20GF150J
6	Terminal Lug	MS35431-1
7	Plate Contact Ring	P-27C95
8	Insulator Ring	P-32A50
9	Terminal Stud	P-9A7
10	Contact Ring	P-AA145-2
11	Contact Ring	P-AA145-1
12	Tuning Rod	PA27A154-2
13	Tuning Rod	PA27A154-1
14	Cavity	P-AB139
15	Feedback Contact	P-AA144
16	Nylon Bushing	PA32A71
17	Feedback Probe	P-27A91
18	Setscrew	AN656DC6H3
19	Filter Body	PA27A146
20	Wire (MIL-W-76A)	NW-C-20(10)V1
21	Capacitor, 25 $\mu\mu$f (8C6)	P-65B3-3 or 565B7-4
22	Spacer	P-29B85-1
23	Capacitor, 25 $\mu\mu$f (8C5)	P-65B3-2 or 565B7-3
24	Coupling Assembly	GB220
25	Cable Assembly (8W9)	GB300-2
26	Screw	582-187-C2-52
	Washer	MS35338-79
27	Terminal Stud	509A13
28	Wire	PA95A4-15
29	Contact Rod	PA27A154-1
30	Sleeve Insulator	P-29B84-2
31	Insulator Bushing	PA32A71
32	Contact Plate	PA15A214
33	Contact Spring	PA18A15
34	Machine Screw	542-312-C2-52
	Washer	MS35338-78
35	Nut	AN340C3
	Washer	P-4A9
36	Stop Stud	PA27A143
37	Lead Screw	PAAA220
38	Nut	AN340C3
	Washer	P-4A9
39	Backlash Nut	PA27A156
40	Setscrew	PA27A140
	Washer	MS35333-71
41	Spring Washer	P-4A10-1
42	Tuning Shaft	P-AB147
43	Ball Bearing	P-30B15-1
44	Screw	562-312-C2-52
	Washer	MS35338-79
45	Setscrew	AN565DC6H3
46	Filter Body	PA27A146
47	Capacitor, 500 $\mu\mu$f (8C8)	P-65B3-5 or 565B7-6
48	Spacer	P-29B85-1
49	Capacitor, 500 $\mu\mu$f (8C9)	P-65B3-4 or 565B7-5
50	Plug Screw	PA27A114
51	Truarc Ring	5000-112W
52	Spring Washer	P-4A10-1
53	Locknut	P-2A8-1
54	Spacer	PA27A152
55	Packing Gland	P-4A4
56	Rear Cover	PA27A153
57	Machine Screw	562-875-C2-52
	Washer	MS35338-79
58	Coil (8L3) (3 turns)	No. 20 AWG wire
59	Coil (8L4) (3 turns)	No. 20 AWG wire

(item 27).

Step 17. Remove center contact rod (item 29) with contact plate (item 32) and insulators (items 30 and 31). This assembly can be taken apart by unsoldering the other end of wire (item 28) and removing nut (item 35).

Step 18. To remove oscillator tuning shaft from housing, unscrew four screws with washers (item 57) holding the rear cover with packing gland and rear cover (items 55 and 56). Remove cover (item 56) and spacer (item 54).

Step 19. Loosen and remove two locking nuts (item 53) and washer (item 52). The tuning shaft (item 42) now can be removed from inside the housing.

Step 20. Remove both ball bearings (item 43) by pushing them out with a wooden or similar soft tool. The two Truarc retaining rings (item 51) can be removed by expanding their ends with a pair of long-nose pliers or similar tool.

Step 21. Remove filament filter assembly 8Z3 (item 46) by loosening setscrew (item 45) and pulling the wire unsoldered from terminal stud (item 27) out of the housing. Capacitors 8C8 and 8C9 (items 47 and 49) and coil 8L4 (item 59) located inside spacer (item 48) can be then further disassembled if required.

(c) REASSEMBLY AND MOUNTING TO BASE PLATE. - To reassemble and mount the rf oscillator assembly (figure 5-5), proceed as follows:

Step 1. Assemble filament contact rod (item 29), plate (item 32), four insulating spacers (item 30),

insulator bushing (item 31), and nut with washer (item 35).

Step 2. Insert this assembly into cavity (item 14) and secure by placing contacts (item 33) under each of the three screws and washers (item 34). See that locating edges of the contacts are in holes provided for them on plate (item 32).

Step 3. Install terminal stud (item 27) and solder one end of the short length of wire with sleeving (item 28) to contact rod (item 29) and the other end to terminal stud (item 27).

Step 4. Assemble tuning rods (item 12) to contact ring (item 10) and tuning rods (item 13) to contact ring (item 11).

Step 5. Apply a thin coat of molybdenum disulphite (Molycote type Z, by Alpha Corp., Greenwich, Conn.; Admiral part number 551B7-16) to contact areas of both contact rings (items 10 and 11).

Step 6. Insert contact ring assemblies into cavity (item 14). Push out the tuning rods of both contacts as far as possible and apply molybdenum disulphite to points of contact with three-prong contacts (item 33).

Step 7. Move contact ring assemblies (items 10 and 11) in and out several times to assure that they slide without excessive binding.

Step 8. Attach travel stop (item 36) to brazed plate of lead screw (item 37) and then to protruding tuning rods using six nuts and washers (item 38). Make certain that the half-round cutout on the plate is located above terminal stud (item 27).

Step 9, Apply molybdenum disulphite to thread of lead screw (item 37) and screw on backlash nut (item 39) with setscrew and washer (item 40) in place.

Step 10. With spring washer (item 41) in place, screw the shaft onto lead-screw, bringing backlash nut into contact with the shaft until spring washer is partly compressed. Adjust the compression of the spring washer until the shaft can be turned with 5 to 7 inch-ounce torque, then tighten setscrew (item 40) so that it enters one of the notches on the shaft body.

Step 11. Install two Truarc rings (item 51) and both ball bearings into housing. Make certain that ball bearings are well seated.

Step 12. Install assembled plate filter (item 46) by pulling wire inside housing and tightening setscrew (item 45).

Step 13. Depress tuning rods completely and insert cavity assembly (item 14) into housing with the shaft protruding through ball bearings. Solder wire from filter (item 46) to terminal stud (item 27). Dress wire so it will not short to other parts of the assembly.

Step 14. Align flange flats on cavity and housing, pull threaded portion of tuning shaft through ball bearings, and fasten with five screws and washers (item 44).

Step 15. Place spring washer (item 52) with its convex side against bearing. Adjust and tighten locknuts (item 53) so that the shaft has no end play and can be turned with torque between 15 and 20 inch-ounces.

Step 16. Install packing gland (item 55) into rear cover (item 56), and spacer (item 54), and fasten them to housing with screws and washers (item 57).

Step 17. Install teflon insulator (item 16) into hole in center tube of cavity by pushing it into place from outer side. Slide feedback contact into place on inner tube. Fasten both with feedback probe (item 17) using an Allen wrench. Install cover screw with washer (item 26).

Step 18. Place teflon insulator (item 8) with terminal stud (item 9) installed on top of cavity, add plate contact ring (item 7), and fasten with five nylon screws (item 4). Place lug (item 6) under nylon screw next to stud (item 9). Connect and solder resistor 8R40 (item 5) between lug and terminal stud.

Step 19. Install assembled filter 8Z1 (item 19), fasten setscrew (item 18), and solder wire (item 20) to terminal stud (item 9).

Step 20. Insert tube 8V2 (item 3), screw in retainer ring (item 2) and add cap (item 1).

Step 21. Install coupling (item 24) and tighten setscrew.

Step 22. To mount the rf oscillator assembly to the base plate, reverse the procedure in paragraph 5-4f(6)(a).

(7) ALC/ATTENUATOR ASSEMBLY 8A2.

(a) REMOVAL FROM BASE PLATE ASSEMBLY. - Remove four screws that hold rear of assembly to base plate. Remove three screws with washers that hold front of assembly to base plate. Loosen two Allen head setscrews that hold spur gear on assembly center shaft at front of base plate. Disconnect cable 8W6 (8P53) from J53 on Directional Coupler Assembly 8A9. Remove attenuator assembly by grasping it at front and rear and carefully pulling

it out of rear of base plate assembly.

(b) DISASSEMBLY. - To disassemble ALC/Attenuator Assembly (figure 5-6), proceed as follows:

Step 1. Remove four screws and washers (item 11) and remove housing cap and socket assembly (item 2) by pulling it off the tube.

Step 2. If required, remove two tube socket mounting screws (item 6). This makes accessible tube socket (item 5), capacitor 8C1 (item 3), and grounding wire with lug (item 4).

Step 3. Remove tube 8V1 (item 7) by gently rocking and pulling.

Step 4. Remove three screws with washers (item 9) and remove contact ring (item 8) by sliding it out.

Step 5. Unsolder from contact plate (item 12) center wire of signal input cable assembly (item 10) and lead of resistor 8R1 (item 16).

Step 6. Remove four screws and washers (item 11) and remove input cable assembly (item 10).

Step 7. Loosen setscrew (item 14) and remove filter assembly 8Z2 (item 15). This makes accessible resistor 8R1 (item 16), capacitors 8C2, 8C3, and 8C4 (items 17, 19, and 21), and spacers containing coils 8L1 and 8L2 (items 18 and 20).

Step 8. Loosen setscrew (item 24) and remove plunger assembly (item 29) from the cavity by pulling it out with all the parts attached to it, including lead screw clamp (item 23).

Step 9. If required, remove contact plate (item 12) by pushing it out with a suitable round tool through plunger cavity. Insulating spacer (item 13) can be removed by carefully pulling it off its mounting lip.

Step 10. Remove sliding contact (item 22) and lead screw clamp (item 23) from plunger by unscrewing.

Step 11. To gain access to resistor 8R2 (item 26) or coaxial cable connection to cavity coupling contact (item 25), loosen setscrew (item 28). Apply the tip of a hot soldering iron to edge of the cutout near the end of the plunger opposite resistor 8R2 (item 26), and push coaxial cable through plunger and sleeve (item 33) forward as shown on enlarged sectional view of figure 5-6. Remove resistor 8R2 by heating tip of contact (item 25) and unsoldering outer conductor of coaxial cable. After removing conical retainer (item 27), coaxial cable can be withdrawn for replacement, if necessary.

Step 12. Loosen two locking nuts (item 38), and separate attenuator shaft from mounting bracket (item 37).

Step 13. Remove two ball bearings (item 36) by knocking them out from inside of the mounting bracket (item 37) with a suitable tool made of wood or similar material.

(c) REASSEMBLY AND MOUNTING TO BASE PLATE. - To reassemble and mount the ALC/attenuator assembly, proceed as follows (figure 5-6):

Step 1. Install ball bearings (item 36) into mounting bracket (item 37). Insert tuning shaft (item 35) and tighten one locknut (item 38) until the shaft has no end-play and can be turned with no more than 5 inch-ounces of torque. Carefully tighten second locknut and recheck end-play and torque.

Step 2. Thread backlash nut (item 32) on lead screw full length of thread to make certain there are no tight spots.

Step 3. Reassemble plunger assembly (item 29) by inserting resistor 8R2 (item 26) into hole provided for it and soldering the resistor lead protruding into cutout on plunger. Slide sleeve (item 33) onto coaxial cable from SG OUT connector (item 34) and pull cable through plunger (item 29). Strip the dielectric and braiding back 5/8 inch from end of cable, exposing center conductor. Strip off an additional 3/8 inch of outside insulation and comb out braid. Insert conical retainer (item 27) under combed portion of braid. Insert conical retainer until combed portion of braid is flush with dielectric, pull coaxial cable back in until flush with end of plunger and trim off any protruding braid. Tighten setscrew (item 28). Slip lead screw clamp (item 23) onto plunger. Bend the offset center conductor of coaxial cable as indicated in enlarged cutout in figure 5-6. Form resistor lead into pickup loop around coaxial conductor as shown and solder both together. Feed coaxial cable center conductor through contact (item 25), thread on sliding contact (item 22), and solder flush with top of contact. Remove sliding contact (item 22), apply Glyptol to threads on plunger and replace contact, threading on finger-tight.

Step 4. Install insulator ring (item 13)

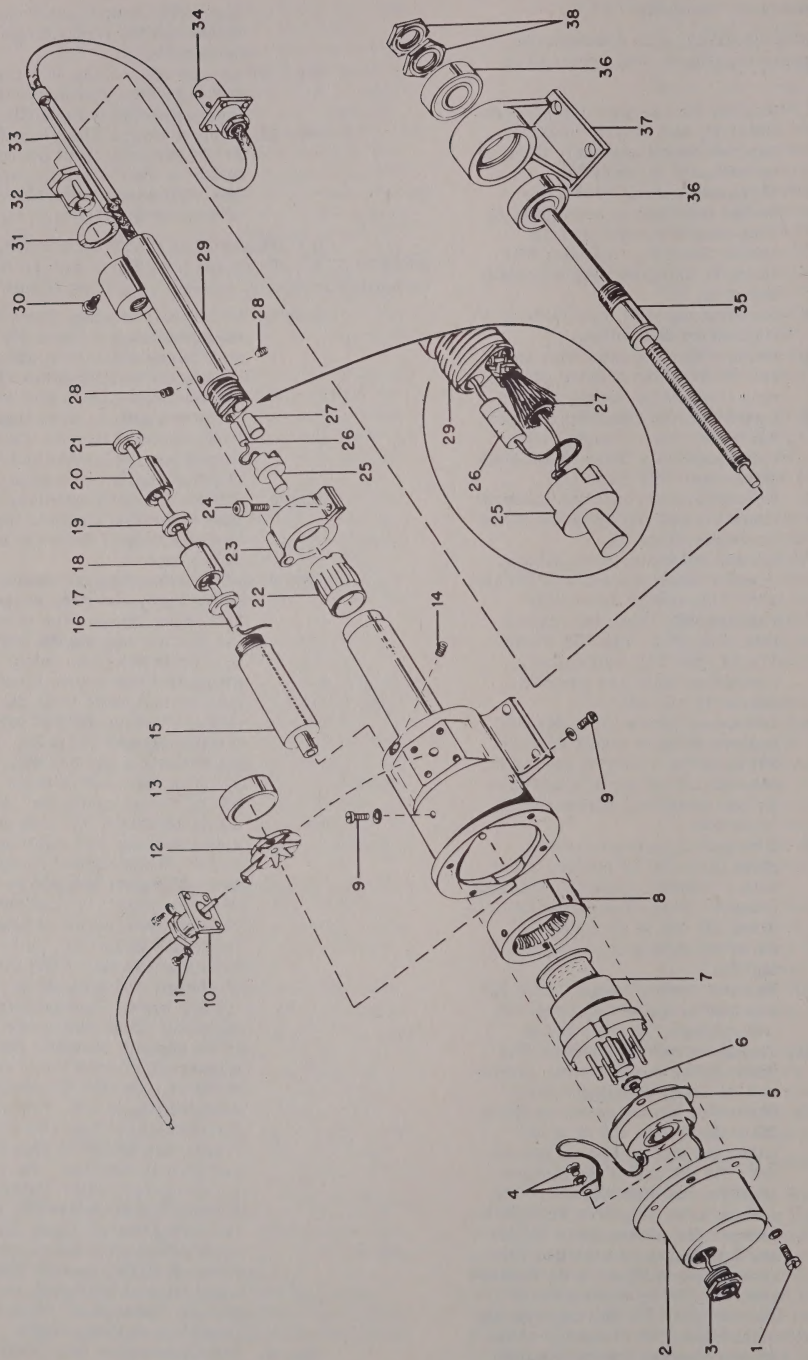


Figure 5-6. ALC/Attenuator Assembly 8A2, Exploded View

Table 5-7. ALC/Attenuator Assembly 8A2, Parts Identification

Call Out No. (Figure 5-6)	Description	Admiral Part/Dwg No.
1	Machine Screw	542-312-C2-52
	Washer	MS35337-78
2	Shield	P-20B33
3	Capacitor, 200 $\mu\mu$f (8C1)	PA65A1 or 565A11
4	Terminal Lug	MS35431-1
	Machine Screw	542-187-C2-52
	Washer	MS35337-78
5	Tube Socket	PA87A6
6	Machine Screw	565-125-C2-52
7	Electron Tube (8V1)	2B22
8	Contact Ring	PAAA256
9	Machine Screw	542-250-C2-52
	Washer	MS35337-78
10	Cable Assembly	P-AA155
11	Machine Screw	522-281-C2-52
	Washer	MS35337-77
12	Contact Assembly	P-AA153
13	Insulating Spacer	P-29B84-3
14	Setscrew	AN565DC6H3
15	Filter Body	PA27A183
16	Resistor (8R1)	RC20GF150J
17	Capacitor, 25 $\mu\mu$f (8C2)	P-65B3-2 or 565B7-3

Call Out No. (Figure 5-6)	Description	Admiral Part/Dwg No.
18	Spacer	P-29B83-1
19	Capacitor, 25 $\mu\mu$f (8C3)	P-65B3-3 or 565B7-4
20	Spacer	P-29B83-2
21	Capacitor, 25 $\mu\mu$f (8C4)	P-65B3-2 or 565B7-3
22	Contact	PAAA283
23	Lead Screw Clamp	P-20A28
24	Hexagon Cap Socket Hd Screw	6-32NC-3A(3/8)
25	Contact	P-AA156
26	Resistor (8R2)	RC20GF470J
27	Retainer	PA27A110
28	Setscrew	501A7-2
29	Plunger	PAAA162
30	Lock Screw	P-1A6
31	Spring Washer	MS35337-78
32	Backlash Nut	PA27A179
33	Sleeve	PA27A176
34	Connector (8J6)	UG-291A/U
35	Lead Screw	PA27A175
36	Ball Bearing	P-30B15-2
37	Mounting Bracket	PA20A47
38	Locknuts	P-2A8-2

and star-shaped contact (item 12) into housing. Secure with phenoweld adhesive cement by applying to end of insulator. Do not allow any cement to adhere to sides of insulator.

Step 5. Install coupling assembly (item 10) using four screws and washers (item 11). Solder protruding end of coaxial cable center conductor to metal strip on contact (item 12).

Step 6. Install filter assembly 8Z2 (item 15), fasten setscrew (item 14), and solder lead of resistor 8R1 (item 16) to nearest point on contact (item 12).

Step 7. Install ring contact (item 8) and fasten with three screws and washers (item 9).

Step 8. Assemble housing cap (item 2), tube socket (item 5), grounding lug (item 4), and capacitor 8C1 (item 3). Insert tube 8V1 (item 7) into tube socket. Install entire assembly into housing, orient properly, and fasten using screws and washers (item 1).

Step 9. Assemble lead screw assembly completed in step 2 to plunger assembly completed in step 3 with spring washer (item 31) in between. Adjust backlash nut for 4 to 6 inch-ounce torque on lead screw. Tighten lockscrew (item 30).

Step 10. Insert assembly completed in step 9 into assembly completed in step 8. Do not tighten set screw of lead screw clamp (item 24).

Step 11. Mount complete ALC/Attenuator assembly loosely on cast mounting plate and align plunger assembly with cavity assembly by operating lead screw clamp setscrew (item 24). Recheck for free movement of lead screw through entire range.

(8) WAVEMETER ASSEMBLY 8A3.

(a) REMOVAL FROM BASE PLATE ASSEMBLY. - Loosen two Allen head setscrews that hold spur gear to wavemeter center shaft at front of base plate. Unscrew three screws with washers that hold assembly to front of base plate. Unscrew two screws with washers that hold center portion of assembly to base plate. Carefully lift assembly from base plate.

(b) DISASSEMBLY. - To disassemble wavemeter assembly (figure 5-7), proceed as follows:

Step 1. Remove spacer (item 2). Unscrew five screws with washers (item 22) which hold together housing (item 7) and cavity (item 23).

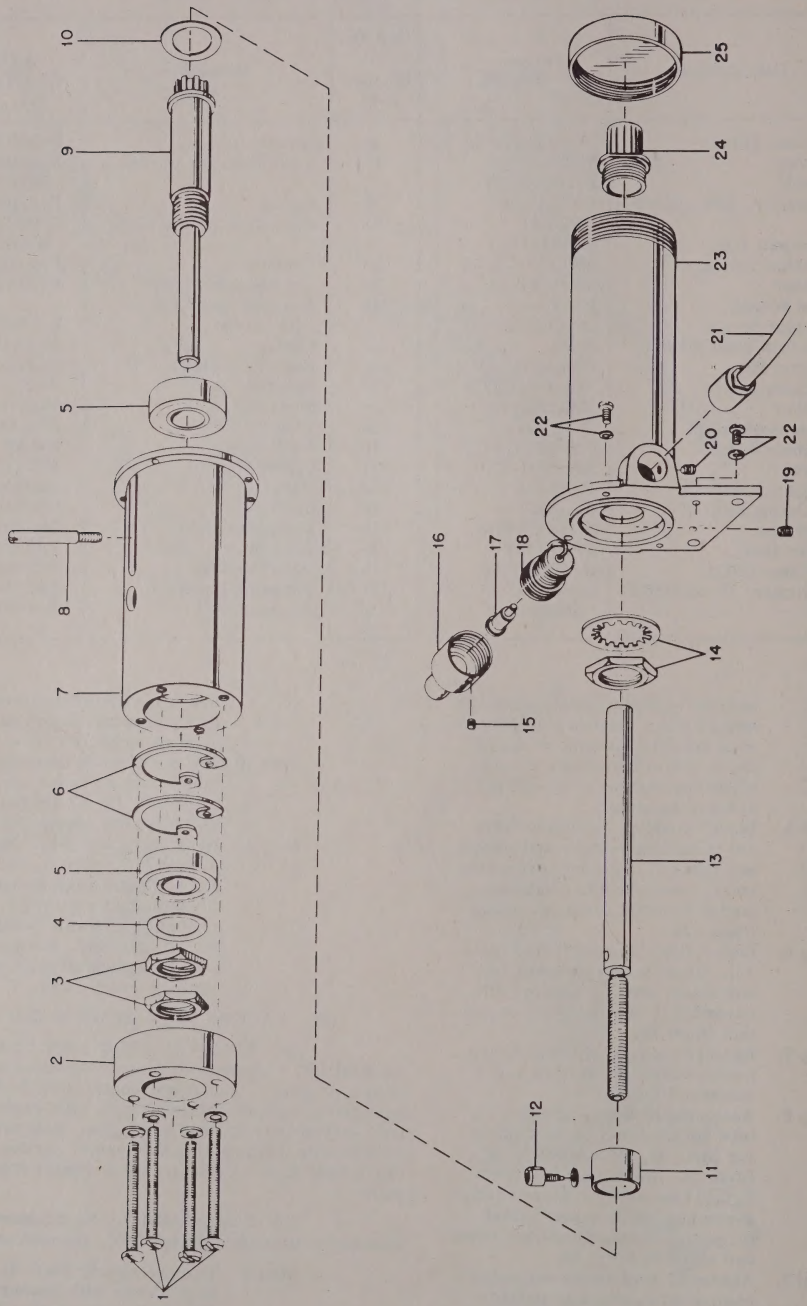


Figure 5-7. Wavemeter Assembly 8A3, Exploded View

Table 5-8. Wavemeter Assembly 8A3, Parts Identification

Call Out No. (Figure 5-7)	Description	Admiral Part/Dwg No.
1	Machine Screw	182-500-C2-3
	Washer	503A5-36-3
2	Spacer	527A474
3	Locknut	P-2A8-1
4	Spring Washer	P-4A10-1
5	Ball Bearing	P-30B15-1
6	Truarc Ring	5000-112W
7	Housing	PA27B34
8	Anti-rotate Pin	PA27A148
9	Tuning Shaft	P-AB159
10	Spring Washer	P-4A10-1
11	Backlash Nut	PA27A147
12	Cup Head Screw	PA27A140
	Washer	MS35337-71
13	Lead Screw	PA27A123
14	Nut	PA203-1
	Lockwasher	503B4-79-78
15	Setscrew	AN565DC6H3
16 & 18	Crystal Holder Assembly (Cap and Body)	PAAB241
17	Crystal Diode (8CR1)	1N25
19	Setscrew	AN565DC6H3
20	Setscrew	AN565DC6H3
21	Cable Assembly	PAAC172
22	Machine Screw	542-312-C2-52
	Washer	MS35337-78
23	Cavity	PAAB221
24	Plunger Contact	PA27A145
25	Cover	PA27A116

Separate the two parts by pulling apart. Take care not to damage the tuning stub protruding into the cavity.

Step 2. Remove plunger anti-rotate screw (item 8) with a screwdriver.

Step 3. Remove two locknuts (item 3) and washer (item 4), if present. Pull out attenuator shaft (item 9) and tuning stub (item 13) assembly. Separate the two by unscrewing.

Step 4. Loosen setscrew (item 15), unscrew crystal holder cap (item 16), and remove crystal diode 8CR1 (item 17) by pulling out of crystal holder (item 18).

Step 5. Loosen setscrew (item 19) and remove crystal holder body (item 18) by unscrewing.

Step 6. Loosen setscrew (item 20) and pull out input cable assembly 8W2 (item 21).

Step 7. Remove cover (item 25), unscrew nut with lockwasher (item 14), and remove tuning stub contact (item 24).

(c) REASSEMBLY AND MOUNTING TO BASE PLATE. - To reassemble and mount the wavemeter assembly 8A3 (figure 5-7), proceed as follows:

Step 1. Apply a thin coat of molybdenum disulphite grease to threads of lead screw (item 13). Thread on backlash nut (item 11) with setscrew and washer (item 12) in place.

Step 2. Place spring washer (item 10) on shoulder of tuning shaft (item 9) and thread half way on lead screw. Tighten backlash nut (item 11) until the lead screw has no end-play and the shaft can be turned with 5 to 7 inch-ounce torque. Tighten backlash nut setscrew (item 12) so that it enters nearest slot on the shaft. Recheck torque.

Step 3. Insert Truarc retaining rings (item 6) into housing and install both ball bearings (item 5) so that they seat against the retaining rings.

Step 4. Install shaft and lead screw assembly into housing. Tighten locknuts (item 3) so that shaft has no end-play and torque is between 15 and 20 inch-ounces.

Step 5. Install anti-rotate screw (item 8) through slot in housing.

Step 6. Install contact (item 24) into cavity (item 23) and fasten with nut and lockwasher (item 14).

Step 7. Apply a thin coat of molybdenum disulphite to tuning stub (item 13) protruding from housing. With flanges oriented as shown in figure 5-7, insert tuning stub into contact (item 24). Fasten cavity and housing together with five screws and washers (item 22).

Step 8. Inspect the half-turn wire loop on the narrow end of the crystal holder body (item 18). Make certain it is not distorted and that a No. 22 drill can be slipped through it. Thread the crystal holder body into the cavity (item 23) so that the coupling loop is oriented parallel to the axis of the tuning stub and the grounded part of the loop is toward the gear train. Fasten setscrew (item 19). Place crystal 8CR1

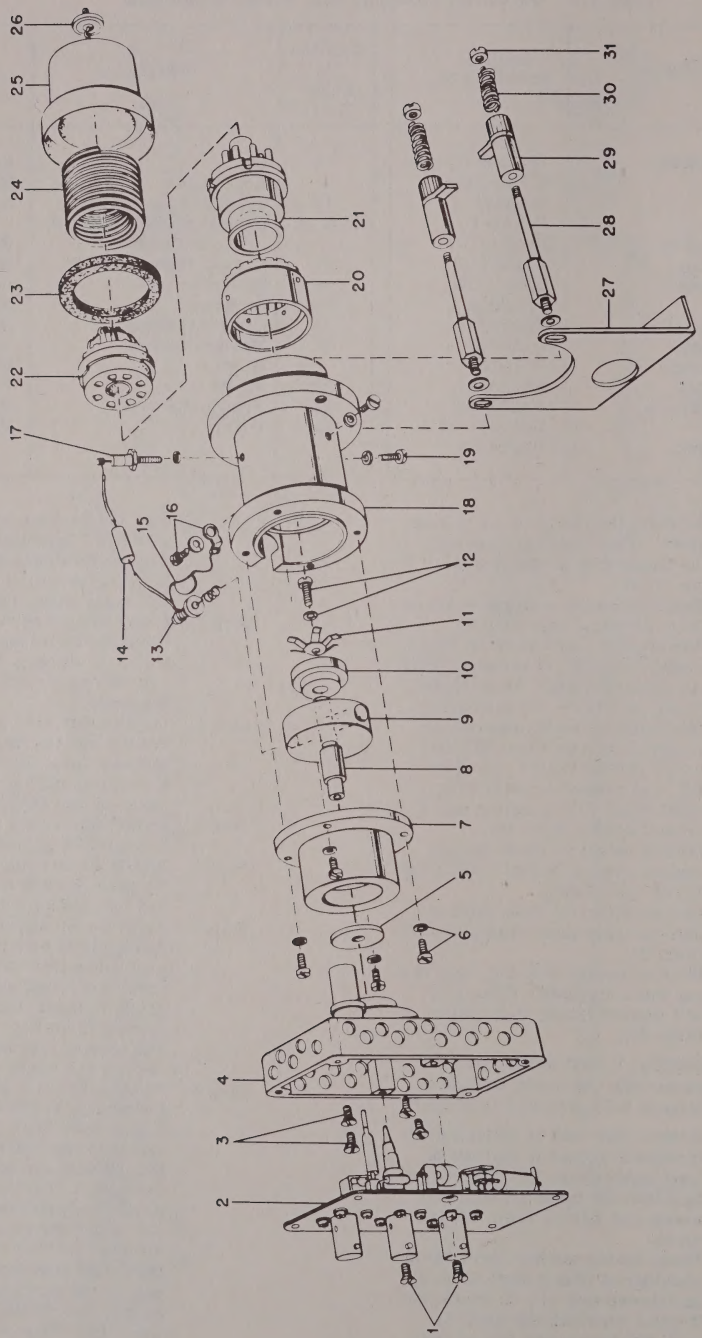


Figure 5-8. Demodulator Assembly 8A4, Exploded View

Table 5-9. Demodulator Assembly 8A4, Parts Identification

Call Out No. (Figure 5-8)	Description	Admiral Part/Dwg No.
1	Machine Screw	LL54J62S6
2	Front Plate Assembly	GD287-2
3	Machine Screw	561-625-C2-52
4	Housing	PAAB183
5	Insulator	PA32A74
6	Machine Screw	542-375-C2-52
	Washer	MS35338-78
7	Spacer	PA27A168
8	Sleeve	PA27A160
9	Insulator	PA32A76
10	Tube Stop	PA27A130
11	Contact Spring	PA18A14
12	Machine Screw	142-375-C2-42
	Washer	503A5-33-42
13	Terminal Stud and RF Coil Assembly (8L9)	PAAA179
14	RF Coil, 3.3 μh (8L10) (Jeffers Electr.)	10102-20
15	Capacitor, 2.2 $\mu\mu$f (Centralab) (8C13)	TB60229DCOK
16	Terminal Lug	MS35431-1
	Machine Screw	542-375-C2-52
17	Terminal Stud	MS35338-78
18	Cavity	PA27B104
19	Machine Screw	542-375-C2-52
	Washer	MS35338-78
20	Contact Ring	PAAA255
21	Electron Tube (8V3)	2B22
22	Tube Socket	587B52
23	Wire Mesh	536A27-2
24	Spring	519C12-52
25	Tube Socket Shield	585B22
26	Capacitor, 100 $\mu\mu$f (8C14) (MIL-C-10950)	CB11ND101K
27	Mounting Bracket	PA15A210
28	Tube Retainer Stud	PA27A103
29	Tube Retainer	PAAA182
30	Spring	PA19A8
31	Round Nut	PA27A172

(item 17) in holder, thread on crystal holder cap (item 16) until finger-tight, and tighten setscrew (item 15).

Step 9. Install 8P12 termination of cable 8W4 (item 21) in a manner similar to that described in step 8, and tighten setscrew (item 20).

Step 10. Taking care not to force anti-rotate pin (item 8) against end of slot, rotate shaft and observe tuning stub through end opening of cavity to make certain it does not wobble.

Step 11. Thread cover (item 25) into place.

Step 12. To mount the assembly to the base plate, reverse the procedure in paragraph 5-4f(7)(a).

(9) DEMODULATOR ASSEMBLY 8A4.

(a) REMOVAL. - Unscrew four screws with washers that hold assembly to front panel. Disconnect 8P11 from 8J11 on demodulator. Unsolder filament lead at rear of assembly. Remove two screws that hold assembly mounting bracket to base plate. Carefully lift assembly out of panel-chassis assembly.

(b) DISASSEMBLY. - To disassemble demodulator assembly (figure 5-8), proceed as follows:

Step 1. Unscrew two flat head screws (item 1) and remove demodulator front plate assembly (item 2) by pulling it straight away from the housing.

Step 2. Unscrew four flat head screws (item 3) and remove front plate housing (item 4) and plastic insulator ring (item 5).

Step 3. Unscrew four screws and washers (item 6) and remove spacer part of the housing (item 7).

Step 4. Unsolder coil 8L10 (item 14) from terminal stud (item 17) and remove screw (item 16) holding a lug on one end of capacitor 8C13 (item 15).

Step 5. Remove insulator disk (item 9) assembled with parts attached to it. Proceed with steps 6 and 7 if it is necessary to further disassemble the insulator disk and contact assembly; otherwise skip to step 8.

Step 6. Remove screw with washer (item 12) and contact spring (item 11) with tube stop (item 10).

Step 7. Apply tip of pencil type soldering tool to sleeve (item 8) through hole in the plastic insulator ring (item 9) opposite terminal stud (item 13) with attached coil 8L9. After solder melts, withdraw terminal stud with coil and remove sleeve (item 8).

Step 8. Turn two tube retainers (item 29) and remove tube socket shield assembly (item 25) and demodulator tube 8V3 (item 21) by gently pulling and rocking them.

Step 9. Unscrew terminal stud (item 17) and two remaining mounting screws with washers (item 19). Slide out contact

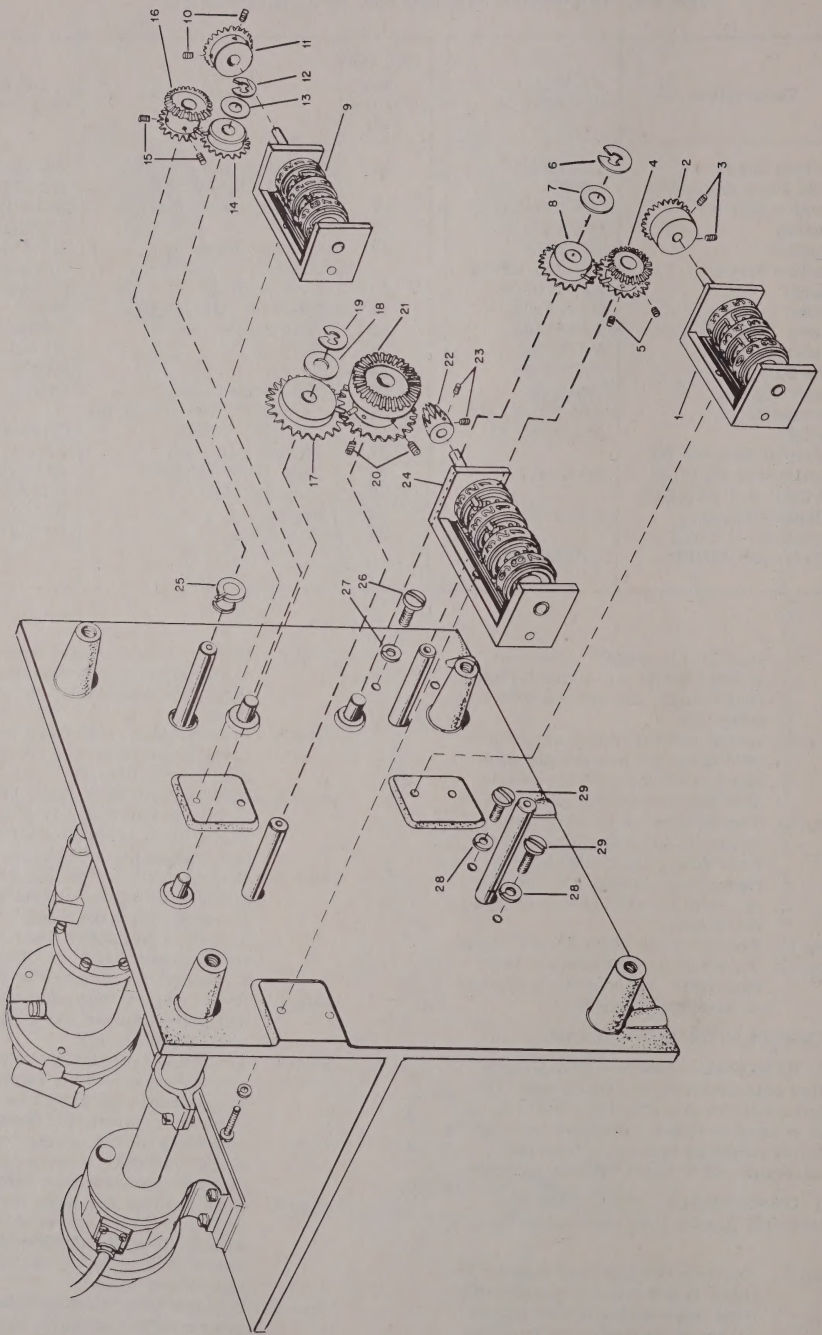


Figure 5-9. Base Plate Assembly, Exploded View

Table 5-10. Base Plate Assembly, Parts Identification

Call Out No. (Figure 5-9)	Description	Admiral Part/Dwg No.
1	Rotating Counter	559B18
2	Bevel Gear	530C62-8
3	Setscrew, #2-56 x 1/8	501C1-70-70
4	Compound Gear Assy	GB1616
5	Setscrew, #4-40 x 1/8	501C1-1-102
6	Flat Washer, #10	504A2-16-52
7	"E" Ring	518B29-7-102
8	Spur Gear Assy	GB1619
9	Rotating Counter	559B18
10	Setscrew, #2-56 x 1/8	501C9-70-70
11	Bevel Gear	530C62-8
12	Flat Washer, #10	504A2-16-52
13	"E" Ring	518B29-7-102
14	Spur Gear Assy	GB1620
15	Setscrew, #4-40 x 1/8	501C1-1-102
16	Compound Gear Assy	GB1617
17	Spur Gear Assembly	GB1618
18	Flat Washer, #10	504A2-16-52
19	"E" Ring	518B29-7-102
20	Setscrew, #4-40 x 1/8	501C1-1-102
21	Compound Gear Assy	GB1615
22	Bevel Gear	530B101
23	Setscrew, #2-56 x 1/8	501C1-70-70
24	Rotating Counter	559B19
25	Bearing Sleeve, Nylon	530B99-6
26	Machine Screw, BH #8-32 x 1-1/2	585-1500-C2-52
27	#8 Split Lockwasher	503A1-66
28	#6 Split Lockwasher	503A1-35
29	Machine Screw, #6-32 x 7/16	565-437-C2-52

ring (item 20).

Step 10. Using a small screwdriver, remove round nuts (item 31) at the end of each tube retainer and slide off retainers (item 29) with springs (item 30) inside them.

Step 11. Press the tube socket (item 22) into shield (item 25) and turn so that the two flat sides of the socket can pass the stops on the shield, and socket is pushed out of the shield by spring (item 24). This makes accessible the parts inside the tube shield.

(c) REASSEMBLY AND MOUNTING. - To reassemble and mount the demodulator assembly (figure 5-8), proceed as follows:

Step 1. Assemble the tube socket (item 22), wire mesh (item 23), spring (item 24), and tube socket shield (item 25). Align the flats on the socket with corresponding flats on the shield, compress the spring, and rotate the socket to engage the stops on the retainer.

Step 2. Fit retainers (item 29) and springs (item 30) onto tube retainer studs (item 28). Fasten with round nuts (item 31).

Step 3. Slide contact ring (item 20) into cavity (item 18). Screw two mounting screws with washers (item 19) and terminal stud (item 17) into the cavity.

Step 4. Insert demodulator tube (item 21) into tube socket shield assembly (item 25). Turn tube retainers (item 29) to secure the tube in position.

Step 5. Insert sleeve (item 8) into insulator disk (item 9). Insert terminal stud and coil (item 13) into insulator disk. Make sure that coil 8L9 is in contact with sleeve (item 8). Apply tip of pencil-type soldering iron to sleeve through hole in insulator disk. Check coil 8L9 for proper electrical connection.

Step 6. Assemble tube stop (item 10) and contact spring (item 11) to insulator disk and sleeve with screw and washer (item 12). Place the insulator disk (item 9) with assembled parts in the cavity (item 18).

Step 7. Fasten mounting lug (item 13) to cavity. Fasten other end of capacitor 8C13 (item 15) to cavity with screw and washer (item 16). Solder coil 8L10 (item 14) to terminal stud (item 17).

Step 8. Assemble spacer portion of housing (item 7) to cavity with four screws and washers (item 6).

Step 9. Connect front plate housing (item 4) and plastic insulator ring (item 5) to assembled cavity with four flat head screws (item 3).

Step 10. Carefully install the demodulator front plate assembly (item 2) to front plate housing with two flat head screws (item 1).

Step 11. Carefully set the assembly in place. Fasten the mounting bracket (item 27) with two screws provided. Connect and solder the filament lead to the rear of the assembly. Connect 8P11 to 8J11 on demodulator. Secure assembly

to front panel with four screws and washers provided.

(10) REASSEMBLY AND INSTALLATION OF RF BASE PLATE ASSEMBLY. - When one or more of the rf assemblies on the base plate have been repaired or replaced, it becomes necessary to recalibrate and realign the unit mechanically and electrically as explained in paragraph 5-51. To install the counting mechanisms on the base plate assembly, proceed as follows:

(a) REASSEMBLY.

Step 1. Turn tuning shaft of ALC/Attenuator Assembly 8A2 counterclockwise to end of rotation, then turn clockwise 1/4 turn. Assemble compound gear (figure 5-9, item 21) to attenuator shaft. Insert setscrews (item 20) into gear but do not tighten. Install spur gear (item 17), flat washer (item 18), and retaining "E" ring (item 19) on the short shaft just above the attenuator shaft. Reinstall the rotating counter (item 24) on the base plate. Place bevel gear (item 22) on counter shaft; place setscrews (item 23) in gear but do not tighten. Without the gear teeth meshing, place the stops as illustrated in figure 5-9. Manipulate the gears until they mesh. Be sure that the positions of the stops are not disturbed. Slide the bevel gear to the right to see if it meshes with the compound gear (item 21). Do not tighten setscrews (item 23) on the bevel gear. Tighten the setscrews (item 20) on the compound gear (item 21).

Step 2. Install nylon bearing sleeve (item 25) on base plate. Rotate rf oscillator tuning shaft fully counterclockwise. Place compound gear (item 16) on rf oscillator shaft. Insert but do not tighten setscrews (item 15). Install bevel gear (item 11) on rotating counter shaft after installing rotating counter onto base plate. Install setscrews (item 10) on gear but do not tighten. Place spur gear (item 14), flat washer (item 13), and retaining "E" ring (item 12) on short shaft just below rf oscillator tuning shaft. Align the compound gear (item 16) and the spur gear (item 14) as shown in figure 5-9. Check to see that the teeth on the gears mesh and that the stops are correctly positioned. Slide the bevel gear to the right to see that the teeth mate with the teeth on the compound gear. Do not tighten setscrews (item 10) on bevel gear (item 11) but tighten setscrews (item 15) on compound gear (item 16).

Step 3. Install rotating counter (item 1) on base plate. Turn wavemeter shaft fully counterclockwise. Place bevel gear (item 2) on rotating counter shaft. Insert setscrews (item 3) into bevel gear but do not tighten. Install setscrews (item 5) into the compound gear (item 4). Place compound gear (item 4) on short shaft just above wavemeter tuning shaft. Install spur gear (item 8), flat washer (item 7), and "E" ring (item 6) on wavemeter tuning shaft. Align the gears (items 4 and 8) so that gear stops are positioned as shown in figure 5-9. Manipulate the gears so that the teeth are engaged. Be careful that the position of the gear stops is not disturbed.

Step 4. Connect base assembly with installed rf units to Radar Test Set AN/UPM-98A and external test equipment for preinstallation calibration and alignment as in paragraph 5-51.

(b) INSTALLATION. - After alignment and calibration, install the base plate assembly into Coder Simulator SM-197A/UPM-98 as follows:

Step 1. Check to see that assemblies 8A1, 8A2, and 8A3 are fastened firmly to base plate assembly.

Step 2. Fasten base plate assembly to coder simulator front panel with four machine screws. Fasten to chassis bottom with five machine screws.

Step 3. Fasten SG OUT connector 8J6 to front panel with four machine screws.

Step 4. Connect and solder filament leads to rf oscillator and ALC/Attenuator assemblies. Connect 8P19 and 8P20 to power supply. Connect 8P7 and 8P3 to rf oscillator assembly. Connect 8P5 to 8J5 on ALC/Attenuator. Connect 8P12 to 8J12 on wavemeter. Connect cable 8W6 between ALC/Attenuator and directional coupler, and cable 8W9 between directional coupler and rf oscillator.

Step 5. Mount SG FREQUENCY, WAVEMETER FREQUENCY, WAVEMETER INPUT, and ATTENUATION front panel knobs in their proper places.

(11) DIRECTIONAL COUPLER ASSEMBLY 8A9.

(a) REMOVAL. - Remove SM-197A/UPM-

98 drawer from Radar Test Set AN/UPM-98A. Stand drawer on end for access to both top and bottom of drawer. Disconnect coaxial cables 8W8 and 8W6 from connectors 8A9J52 and 8A9J53. On the Directional Coupler Assembly, disconnect cable 8W9 from Oscillator Assembly 8A1 by loosening setscrew (item 18, figure 5-5). Remove two screws with lockwashers and nuts mounting assembly to chassis, and remove Directional Coupler Assembly 8A9.

(b) REPLACEMENT. - Remount Directional Coupler Assembly using two screws, lockwashers, and nuts, with the nuts on the top surface of the chassis. Reconnect the three coaxial cables making sure that cable 8W6 connected to 8A9J53 goes to the 8A2 assembly, and cable 8W8 connected to 8A9J52 goes to connector 8J53.

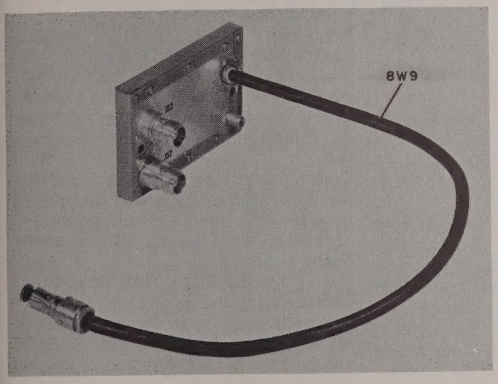


Figure 5-10. Directional Coupler Assembly 8A9

g. REASSEMBLY OF RADAR TEST SET AN/UPM-98A. - To reassemble components of Radar Test Set AN/UPM-98 into an operating unit, proceed as follows:

Step 1. Route ac power cable through access opening on rear wall lower compartment of Electrical Equipment Case CY-2726A/UPM-98 opposite the blower. With cable not connected to main power source, connect its conductors to terminals 2 and 3 on 7TB3 inside the cabinet.

Step 2. Slide Coder Simulator SM-197A/UPM-98 halfway into the lower part of Electrical Equipment Case CY-2726A/UPM-98. Mate 8J21 with 7P3; check action of interlock switch 8S3. Tighten the five heavy captive screws around the front panel so that the sealing gasket is evenly compressed around the unit.

Step 3. Similarly, install Radar Test Set TS-1253A/UP into the upper part of Electrical Equipment Case CY-2726A/UPM-98. Before closing the gap between front panel and the case, connect power distribution cable plug 7P2 to receptacle 5J1 on right hand side of Radar Test Set TS-1253A/UP. Check action of interlock switch 5S2. Tighten five captive screws around front panel so that sealing gasket is evenly compressed around the unit. Radar Test Set AN/UPM-98A is now ready for final examination and testing.

5-5. ELECTRICAL TESTING.

a. TESTING DISPLAY UNIT. - To test, calibrate, and adjust a repaired Display unit, connect it to an operating Radar Test Set TS-1253A/UP using cable assembly CX-4963/UP and CX-4964/UP. Turn power on, allow five minutes of warmup time, and proceed as follows:

Step 1. Measure voltage at pin 10 of rear connector 1P2. Voltage should be 250 +10 vdc.

Step 2. Using high voltage meter probe, measure voltage at pin 7 of 1XZ1. Adjust ANODE SET internal control 1R70 for +1500 vdc.

Step 3. Turn INTEN control fully clockwise. CRT trace should become very bright. Return control to a point giving a normal trace without signs of blooming.

Step 4. Adjust FOCUS and ASTIG controls for sharpest, most even trace.

Step 5. If trace is not parallel to horizontal grid lines, loosen CRT mounts and rotate CRT as required. Tighten mounts.

Step 6. Check that trace can be moved by turning VERT control to move it at least 1.5 inch below and above center line.

Step 7. Check to see that the trace fills the face of CRT with HORIZ control approximately in mid-range. If it does not, readjust ANODE SET control 1R70.

Step 8. Check to see that both ends of trace line can be moved to within one inch of center of CRT screen by turning HORIZ control.

Step 9. Check operation of SCALE control. Scale light should be adjustable from completely out to a bright red glow.

Step 10. Connect oscilloscope to VIDEO connector using a video cable. Set oscilloscope AMPLITUDE CALIBRATOR to 50 millivolts, VOLTS/IN switch to .05, and VIDEO SENS control to CAL. Adjust sweep speed controls so that a single pulse is displayed.

Step 11. Adjust PHASE ADJ (1C34) and FREQ ADJ (1C36) internal controls for best square wave.

Step 12. Adjust GAIN control 1R40 for one-inch pattern height on Display unit CRT.

Step 13. Set oscilloscope AMPLITUDE CALIBRATOR to .1 volts, set VOLTS/IN

switch on Display unit to .1, and adjust 1C1 for a true square wave presentation.

Step 14. Adjust the following trimmer capacitors for true square wave presentation with control settings as listed:

AMPLITUDE CALIBRATOR	VOLTS/IN	ADJUST
.2 volts	.2	1C12
.5 volts	.5	1C20
1 volt	1	1C28
2 volts	2	1C24
5 volts	5	1C32
10 volts	10	1C16
20 volts	20	1C8

Step 15. Remove cable between oscilloscope and VIDEO connector. Set Test Lead MX-2681/UP (video probe) attenuation switch to 10:1, connect cable to VIDEO connector, and connect probe tip to center of CAL OUT connector on oscilloscope.

Step 16. Set oscilloscope AMPLITUDE CALIBRATOR control to .5 volts and VOLTS/IN switch on display unit to .05. Remove white button on side of video probe MX-2681/UP and adjust trimmer capacitor for display presentation of a true square wave.

Step 17. Set MX-2681/UP attenuation switch to 100:1 and oscilloscope AMPLITUDE CALIBRATOR control to 5 volts. Remove probe tip, and using an Allen wrench, adjust trimmer capacitor 6C1 inside the tip for one-inch pattern height on Display unit CRT.

Step 18. Set MX-2681/UP attenuation switch to 10:1. Adjust attenuator padder capacitors for true square wave display with AMPLITUDE CALIBRATOR and VOLTS/IN control settings as follows:

AMPLITUDE CALIBRATOR	VOLTS/IN	ADJUST
1 volt	.1	1C61
2 volts	.2	1C9
5 volts	.5	1C17
10 volts	1	1C25
20 volts	2	1C21
50 volts	5	1C29
100 volts	10	1C13
100 volts	20	1C5

Step 19. Disconnect oscilloscope. Turn power off. Disconnect servicing cables from Display unit.

b. TESTING SWEEP AND INTENSITY MARK UNIT. - To test and adjust the Sweep and Intensity Mark unit, connect it to an operating Radar Test Set TS-1253A/UP with cable assemblies CX-4963/UP and CX-4964/UP. Turn power on, allow five minutes of warmup time, and proceed as follows:

Step 1. Measure voltages at following test points:

Test Point	Voltage
2TP1	+250 ±10 vdc
2TP2	-35 ± 3 vdc
2TP3	-150 ± 2 vdc

Step 2. Turn SWEEP AMPL internal control 2R33 fully counterclockwise. Connect oscilloscope input to pin 9 of 2V5. Turn SWEEP AMPL (2R33) control clockwise until sweep sawtooth starts malfunctioning. Amplitude of sawtooth should reach a minimum of -140 volts without malfunction.

Step 3. Set SWEEP AMPL (2R33) for sweep sawtooth amplitude of 110 volts.

Step 4. Measure sweep duration and trailing edge jitter. Jitter should not exceed 10% of sweep duration. The sawtooth waveshape should be linear throughout.

Step 5. Connect oscilloscope to pin 1 of 2V5. Sweep sawtooth waveshape of opposite polarity as in step 3 should appear. Amplitude shall be ±10 volts of waveshape in step 3.

Step 6. Turn SWEEP SPEED RANGE switch on Sweep and Intensity Mark unit to all positions. Sweep should appear in all positions. Adjust SWEEP SPEED controls for sweep duration of approximately 1200 μsec.

Step 7. Turn OSC FEEDBACK ADJ (2R50) fully counterclockwise. Remove cover from oven 2Z1 for access to 1 mHz FREQ ADJ 2L2. Turn 2L2 fully counterclockwise. Connect oscilloscope input A to cathode of 2CR7. Adjust PRF control so that time between sweeps equals sweep duration. Set INTENSITY MARKS RANGE to 1 and INTENSITY MARKS LEVEL fully clockwise.

Step 8. Turn OSC FEEDBACK ADJ control 2R50 clockwise until intensity marks appear along entire top of intensity gate on oscilloscope display. Turn 2R50 approximately 5 to 10 degrees beyond this point.

Step 9. Connect oscilloscope input B to pin 3 of 3V2 in Crystal Mark and Sync unit. This can be done with a short length of insulated wire routed between front panel and the plug-in unit. Crystal marks should appear on the B trace of the oscilloscope.

Step 10. Set SYNC SELECT switch on Crystal Mark and Sync unit to INT 1.00.

Step 11. Adjust oscilloscope TIME/CM controls for sweep speed of 1 μsec per 2 cm. Adjust oscilloscope DELAY

TIME control for a delay range of 0 to 1000 μsec.

Step 12. Adjust oscilloscope DELAY TIME MULTIPLIER control so that the first intensity mark on top of intensity gate on trace A is coincident with first crystal mark on B trace. Scan slowly to 1000 μsec, adjusting 2L2 so that crystal marks and intensity marks maintain coincidence. At 1000 μsec time delay, difference between both sets of markers should be less than 2 μsec. At completion of this step, tighten locknut on 2L2 and replace oven cover. Tighten locknut on 2R50.

NOTE

If intensity markers disappear before 1000 μsec delay is reached, turn 2R50 slowly clockwise until intensity markers appear, continue turning slowly for an additional 10 degrees, then repeat step 12.

Step 13. Set INTENSITY MARKS RANGE control to 5. Set 5 μsec internal adjustment 2R73 so that intensity markers appear at 5 μsec intervals over 1000 μsec range.

Step 14. Set INTENSITY MARKS RANGE control to 50. Set 50 μsec internal adjustment 2R86 so that intensity marks appear at 50 μsec intervals over 1000 μsec range.

Step 15. Calibrate oscilloscope for 0.1 μsec sweep speed per cm. Connect oscilloscope to pin 6 of 2V10. Adjust 10 mHz transformer 2T3 for maximum amplitude of 0.1 μsec markers.

Step 16. Connect oscilloscope to pin 13 of power connector 2P1. Depress SWEEP DELAY STROBE. A positive pulse should appear.

Step 17. Connect oscilloscope to pin 2 of power connector 2P1. Depress DELAY STROBE TRIGGER. A positive pulse should appear.

Step 18. Disconnect oscilloscope. Turn off power. Disconnect Sweep and Intensity Mark unit.

c. TESTING CRYSTAL MARK AND SYNC UNIT.- To adjust and test the repaired Crystal Mark and Sync unit, connect it to an operating Radar Test Set TS-1253A/UP with a cable assembly CX-4963/UP. Set operating controls as follows:

Control	Setting
SWEEP DELAY RANGE	1-11
SWEEP DELAY COARSE and FINE	fully ccw
TRIGGER DELAY RANGE	0
TRIGGER DELAY COARSE and FINE	fully ccw
SYNC SELECT	INT 1.00
XTAL MARK LEVEL	fully ccw
PRF	fully ccw
SUP	fully ccw

Turn power on, allow five minutes of warmup time, and proceed as follows:

Step 1. Measure following voltages:

Test Point	Voltage
3TP1	+250 ±10 vdc
3TP2	-150 ± 2 vdc

Step 2. Connect input of frequency counter to pin 3 of 3V2 and count crystal marker frequency. Frequency should be between 999,500 and 1,000,500 Hz.

Step 3. Set SYNC SELECT switch to INT 1.45 and count crystal marker frequency. Frequency should be between 689,310 and 690,000 Hz.

Step 4. Connect frequency counter input to 0 TRIGGERS connector. Set SYNC SELECT control to INT. Turn PRF control fully clockwise. Adjust PRF ADJ internal control 3R40 for trigger pulse repetition frequency of 4100 pps or slightly more.

Step 5. Turn PRF control fully ccw. Count prf of triggers. It should be 15 pps or less. If necessary, repeat step 4. Disconnect frequency meter.

Step 6. Set SYNC SELECT control to EXT +. Connect SYNC OUT jack of signal generator to oscilloscope TRIGGER INPUT. Connect PULSE OUT of pulse generator to INPUT TRIGGERS connector of Crystal Mark and Sync unit and to oscilloscope input A. Delay the output of the pulse generator slightly to show the leading edge of the pulse on oscilloscope.

Step 7. Connect oscilloscope input B to 0 TRIGGERS connector. Measure delay between input trigger and 0 trigger pulses. Delay should be 0.25 μsec maximum.

Step 8. Disconnect oscilloscope input B from 0 TRIGGERS and connect to DELAYED TRIGGERS connector. Maximum delay between the two pulses should be 0.25 μsec.

Step 9. Set TRIGGER DELAY RANGE to 1-11. Measure delay. Delay should be less than 1 μsec.

Step 10. Turn TRIGGER DELAY FINE control fully cw. Delay should be 11 μsec minimum.

Step 11. Set TRIGGER DELAY RANGE switch to 5-50 and TRIGGER DELAY FINE control fully ccw. The trigger delay should be 5 μsec maximum. Set TRIGGER DELAY FINE control fully cw. The trigger delay should be 50 μsec minimum.

Step 12. Set TRIGGER DELAY RANGE switch to 50-750 and COARSE and FINE controls fully ccw. The trigger delay should be 50 μsec minimum. Set COARSE and FINE controls fully cw.

The trigger delay should be 750 μsec minimum.

Step 13. Return TRIGGER DELAY RANGE control to 0. Connect a load consisting of 75 ohms paralleled by 1100 pf to DELAYED TRIGGERS connector (in parallel with existing oscilloscope connection). Measure following trigger pulse characteristics:

Characteristic	Acceptable Reading
Amplitude	20 v min
Duration	0.5 to 3 μsec
Rise Time	0.2 μsec max
Decay Time	1 μsec min

Step 14. Disconnect oscilloscope from DELAYED TRIGGERS and move to SUP TRIGGERS connector. Pulse duration should be 2 μsec minimum.

Step 15. Turn SUP control fully clockwise. Measure following pulse characteristics:

Characteristic	Acceptable Reading
Duration	220 μsec min
Amplitude	3 v min
Rise Time	0.4 μsec max
Decay Time	0.4 μsec max

Step 16. Disconnect oscilloscope from SUP TRIGGERS and move to pin 8 of 3V11. Set SWEEP DELAY RANGE control to 1-11. Measure delay between 0 trigger and sweep trigger. Delay should be 1 μsec or less.

Step 17. Turn SWEEP DELAY FINE control fully cw. Delay should be 11 μsec minimum.

Step 18. Set SWEEP DELAY RANGE switch to 11-21. Adjust SWEEP DELAY ADJ internal control 3C44 so that delay is 21 μsec or greater. (Delay of 11-21 range equals delay of 1-11 range plus 10 ±0.5 μsec.)

Step 19. Turn SWEEP DELAY FINE control fully ccw. Delay should be 11 μsec minimum.

Step 20. Set SWEEP DELAY RANGE control to 21-31, and turn SWEEP DELAY FINE fully cw. Adjust SWEEP DELAY ADJ internal control 3C58 so that delay is 31 μsec or greater.

Step 21. Set SWEEP DELAY RANGE control to 5-50. Measure delay. Delay should be 50 μsec minimum.

Step 22. Turn SWEEP DELAY COARSE and FINE controls fully ccw. Measure delay. Delay should be 5 μsec maximum.

Step 23. Set SWEEP DELAY RANGE control to 50-750. Measure delay. Delay should be 50 μsec maximum.

Step 24. Turn SWEEP DELAY COARSE and FINE controls fully cw. Measure delay. Delay should be 750 μsec minimum.

Step 25. Disconnect oscilloscope. Turn power off and disconnect Crystal Mark and Sync unit.

d. TESTING SIF CODER. - To adjust and test SIF Coder, connect it to an operating Radar Test Set TS-1253A/UP with a cable assembly CX-4963/UP. Set operating controls as follows:

Control	Setting
CODE	0000
FUNCTION	N
LEVEL	LO
AMPLITUDE	fully cw
PULSE WIDTH	.45
SUB PULSE POS	0
SUB PULSE SELECT	OFF

Turn power on, allow five minutes warmup time, and proceed as follows:

Step 1. Measure voltages at following test points:

Test Point	Voltage
4TP1 (4J5)	+250 ±10 vdc
4TP2 (4J6)	-35 ± 3 vdc
4TP3 (4J7)	-150 ± 2 vdc
4TP4 (4J8)	-4 ±0.5 vdc

Step 2. Connect oscilloscope input A to VARI OUTPUT receptacle. Calibrate oscilloscope for 5 μsec/cm. Two pulses should appear on the oscilloscope.

Step 3. Set FUNCTION selector to ID. An additional pulse following the two pulses should appear.

Step 4. Set FUNCTION selector to X. A pulse should appear which is centered between the first two pulses.

Step 5. Calibrate oscilloscope for 20 μsec/cm. Set FUNCTION selector to EMER + X. Four pulse trains like the one in step 4 but with the center pulse in only the first train should appear.

Step 6. Set FUNCTION selector to EMER. The center pulse observed in step 4 should disappear from the first code train.

Step 7. Return FUNCTION selector to X. Calibrate oscilloscope for 5 μsec/cm.

Step 8. Turn each of the four CODE selectors from 0 through 7 and check to see that pulses appear and disappear correctly. (See table 4-18 and figure 3-2).

Step 9. Set CODE selectors to 7777. Turn SUB PULSE SELECT switch through all positions. No pulses should disappear; however, a slight shift in position of the substitute pulses may be noticeable. Return SUB PULSE SELECT switch to OFF.

Step 10. Calibrate oscilloscope for 0.1 μsec/cm. Observe C1 pulse. Set WIDTH ADJ internal control 4R47 for 0.45 μsec pulse width at 50% amplitude.

Step 11. Turn PULSE WIDTH control fully ccw. Measure pulse width. Width should be 0.3 μsec maximum.

Step 12. Turn PULSE WIDTH control fully cw. Measure pulse width. Width should be 1 μsec minimum.

Step 13. Return PULSE WIDTH control to .45. Set SUB PULSE SELECT switch to C1. Adjust SUB PULSE AMP internal control 4R32 for substitute pulse width of 0.45 μsec.

Step 14. Connect oscilloscope input A to TRIGGER INPUT using a "T" connector, and input B to a wire connected to pin 3 of 3V2 in Crystal Mark and Sync unit. Set SYNC SELECT control on Crystal Mark and Sync unit to INT 1.00. Calibrate oscilloscope for 0.2 μsec/cm. Using TRIGGER DELAY controls on Crystal Mark and Sync unit, adjust for coincidence between input trigger and a 1 μsec crystal mark.

Step 15. Connect oscilloscope input A to VARI OUTPUT receptacle. Adjust pickoff coil 4L10 so that ST (start) pulse appears approximately 3.5 μsec after input trigger pulse.

Step 16. Set SYNC SELECT control on crystal Mark and Sync unit to INT 1.45. Use TRIGGER DELAY controls to adjust for coincidence between ST pulse and a 1.45 μsec crystal mark.

Step 17. Adjust pickoff coil 4L11 to bring leading edge of C1 pulse into coincidence with the next 1.45 μsec marker.

Step 18. Adjust pickoff coils 4L12 through 4L24 so that the leading edge of each successive pulse in the train is coincident with its corresponding 1.45 μsec marker.

Step 19. Set FUNCTION selector to EMER. Use trigger delay controls to align stop pulse (SP) with a 1.45 μsec marker. Adjust EMER REDRIVE pickoff coil 4L25 so that start pulse of the next train occurs 4.35 μsec (third 1.45 μsec marker) after stop pulse of preceding train.

Step 20. Set FUNCTION selector to ID. Adjust ID pulse pickoff coil 4L26 so that ID pulse coincides with third 1.45 μsec marker after stop pulse.

Step 21. Observe C1 pulse on oscilloscope. Set SUB PULSE SELECT switch to C1. Loosen locking screw on substitute pulse delay line 4DL1 and adjust core for coincidence of C1 pulse and substitute C1 pulse.

Step 22. Observe stop pulse in train. Replace with substitute (SP) pulse by means of SUB PULSE SELECT switch. Adjust SUB PULSE POS internal control 4R141 so that position of stop pulse and substitute (SP) pulse are coincident.

Step 23. Repeat steps 21 and 22 until minimum substitute pulse shift is evident for both C1 and SP pulses.

Step 24. Turn SUB PULSE SELECT switch through all positions and check for substitute pulse shift.

NOTE

It may become necessary to repeat steps 21 through 23 and change setting of C1 pulse position in order to minimize substitute pulse shift over the entire pulse train.

Step 25. Again observe C1 pulse. Replace it with substitute pulse. Set SUB PULSE POS control to -.7, -.2, +.2, and +.7 detent positions and check that the pulse is shifted -0.7, -0.2, +0.2 and +0.7 μsec in relation to the original pulse position. Readjust detent settings if necessary.

Step 26. Calibrate oscilloscope for 0.1 μsec/cm. Check that substitute pulse characteristics are as follows:

Characteristic	Acceptable Measurement
Rise Time	0.05 μsec max
Decay Time	0.1 μsec max
Amplitude	5 v min

Step 27. Set LEVEL switch to HI and check the following pulse characteristics:

Characteristic	Acceptable Measurement
Rise Time	0.1 μsec max
Decay Time	0.12 μsec max
Amplitude	7 v min

Step 28. Connect oscilloscope input A to MOD DRIVE connector. Check following pulse characteristics:

Characteristic	Acceptable Measurement	
	LEVEL at LO	LEVEL at HI
Rise Time	0.1 μsec max	0.1 μsec max
Decay Time	0.15 μsec max	0.2 μsec max
Amplitude	25 v min	45 v min

Step 29. Disconnect oscilloscope. Turn power off. Disconnect SIF Coder from servicing cable.

e. TESTING RADAR TEST SET TS-1253A/UP POWER SUPPLY. - In preparing Radar Test Set TS-1253A/UP for testing, it is necessary to apply input power to it. This can be done either by partly inserting the panel-chassis into Electrical Equipment Case CY-2726A/UPM-98, and connecting the interunit power plug to receptacle 5J1, or by applying 115 vac power directly to pins E and F of receptacle 5J1. If adjustment has to be made on the plug-in units, remove the applicable unit from the panel-chassis and reconnect it to its power plug with a CX-4963/UPM cable assembly (figure 2-3). With all subassemblies installed in the panel-chassis assembly, make the following power supply checks:

Test Point	Acceptable Reading
5TP1 (5J6)	-150 ±2 volts
5TP2 (5J7)	+250 ±10 volts
Pins 3 on 5J2, 5J3, 5J4, and 5J5	-4 ±0.5 volts
Pin 20 on 5J2, 5J3, 5J4, and 5J5	-35 ±3 volts

NOTE

Although +350 volts is available in the power supply, it is not used directly by circuits in the test set. This voltage need only be checked if the +250 volt and -150 volt legs of the power supply cannot be adjusted to within the tolerances.

See table 5-4, step 1, for the adjustment procedure for the negative leg of the power supply.

f. TESTING SM-197A/UPM-98 POWER SUPPLY.- Energize the SM-197A/UPM-98 assembly by applying ac input power to pins C and D on 8J21. Lift interlock lever associated with the switch, press roller arm down, and press button (behind roller arm) down until it clicks. Allow several minutes warmup time, then make the following voltage checks:

Test Point	Acceptable Reading
8TP1 (8J27)	-30 ±3 volts
8TP2 (8J26)	-5 ±0.5 volts
8TP3 (8J24)	+300 ±30 volts
8TP4 (8J25)	+105 ±15 volts

NOTE

Refer to table 5-5, step 1, for adjustment procedure for the +300 volt leg of the power supply.

g. TESTING INTERROGATION CODER. - The Interrogation Coder circuitry of Coder Simulator SM-197A/UPM-98 can be tested and adjusted using either a suitable external oscilloscope or the oscilloscope of a properly operating Radar Test Set TS-1253A/UP. For the procedure described below, a TS-1253A/UP is used.

Step 1. Remove the Interrogation Coder from the panel-chassis and reconnect with Cable Assembly CX-6092/U. Measure the following voltages:

Test Point	Acceptable Reading
12TP1	-30 ±3 volts
12TP2	-12 volts
12TP3	+12 volts
12TP4	+25 volts
12TP5	+300 ±30 volts

Remove Cable Assembly CX-6092/U and reinstall Interrogation Coder in the panel-chassis assembly.

Step 2. Connect CODER OUT connector on Interrogation Coder to VIDEO connector on TS-1253A/UP Display unit with a video cable. Connect DELAYED TRIGGERS on Crystal Mark and Sync unit to TRIG connector on Interrogation Coder.

Step 3. Set operating controls on TS-1253A/UP as follows:

Control	Setting
VOLTS/IN	20
SWEEP DELAY RANGE	1-11
SWEEP DELAY FINE	as required
INTENSITY MARKS RANGE	1 and .1
SYNC SELECT	INT
PRF	approx. 1000 pps
TRIGGER DELAY RANGE	1-11
TRIGGER DELAY FINE	as required
SWEEP SPEED RANGE	1-30
SWEEP SPEED ADJUST	as required
75 Ω	IN

Step 4. On Interrogation Coder, set Function Selector 12S2 to (+) position. On Display unit, set VIDEO SENS control to CAL position and VOLTS/IN switch to 20. Change the setting of the VIDEO LEVEL control to check for a pulse amplitude of 35 volts minimum.

Step 5. Set Mode Selector 12S1 to 2 position. Check for pulse spacing of 5 ±0.05 μsec.

Step 6. Set Substitute Pulse Position control to the following detent positions and record time shift of first pulse with respect to the 0 position.

Pulse Position	Time Shift
-.2	.2 ±0.05 μsec
-.7	.7 ±0.05 μsec
+.2	.2 ±0.05 μsec
+.7	.7 ±0.05 μsec

Return Substitute Pulse Position control to 0 position.

Step 7. Set Mode Selector 12S1 to 1 position. Check for pulse spacing of 3 ±0.05 μsec.

Step 8. Set Mode Selector 12S1 to 3/A position. Check for pulse spacing of 8 ±0.05 μsec.

Step 9. Set Mode Selector 12S1 to C position. Check for pulse spacing of 21 ±0.05 μsec.

Step 10. Set Mode Selector 12S1 to SYNC M4 position. Check for four pulses spaced 2 ±0.05 μsec apart.

Step 11. Set Mode Selector 12S1 to 1 position. Set SWEEP SPEED RANGE to 1-20. Set CODE WIDTH control to maximum counterclockwise position. Check for following output pulse characteristics:

Duration	- 0.35 μsec max
Rise Time	- 0.11 μsec max
Decay Time	- 0.2 μsec max

Step 12. Set CODE WIDTH control to maximum clockwise position. Check the following output pulse characteristics:

Duration	- 1.3 μsec min
Rise Time	- 0.11 μsec max
Decay Time	- 0.2 μsec max

If necessary, adjust WIDTH ADJ control 12R42 inside the Interrogation Coder for correct pulse duration (width).

Step 13. Set Function Selector to (-) position. Measure and record pulse characteristics as in step 12.

Step 14. Connect output of external pulse generator to MOD connector (12J3) on Interrogation Coder. On Calibration-Control unit, set TRIGGER Selector 9S1 to DEMOD and VIDEO OUT switch 9S2 to SG MON. Set the SG FREQUENCY to approximately 1000 mHz and Function Selector on Interrogation Coder to MOD-HIGH position. Connect an rf cable from VIDEO OUT on Calibration-Control unit to VIDEO INPUT on Display unit.

Step 15. Set prf of external pulse generator to approximately 1000 pps at output amplitude of 30 to 50 volts. Check pulse display on CRT.

Step 16. Set generator output to 5 to 30 volt level. Set Function Selector on Interrogation Coder to MOD-LOW. Check pulse display on CRT.

h. TESTING CALIBRATION-CONTROL UNIT.

Step 1. Remove unit from panel-chassis, reconnect with Cable Assembly CX-6092/U, and measure the following voltages:

Test Point	Acceptable Reading
9TP1 (9J5)	+300 ±30 volts
9TP2 (9J6)	+105 ±15 volts
9TP3 (9J7)	-30 ± 3 volts
9TP4 (9J8)	-5 ±0.5 volts

Reinstall Calibration-Control unit in panel-chassis assembly.

Step 2. Connect test equipment as shown in figure 5-11. Set METER SELECT switch 9S3 to 500 PRF position. Set TRIGGER Selector 9S1 to EXT position. Set pulse triggering rate of pulse generator to 500 prf. If necessary, adjust 0-500 PRF control 9R30 for an indication of 500 on the meter.

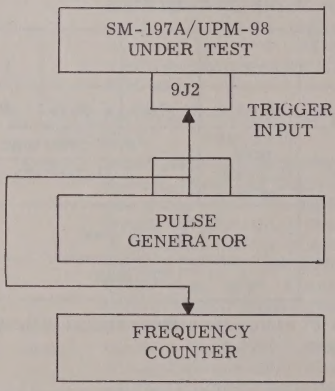


Figure 5-11. Calibration-Control Unit Pulse Counter Test Setup

Step 3. Set METER SELECT switch to 5000 PRF position. Set triggering rate of pulse generator to 5000 pps. If necessary, adjust 0-5000 PRF control 9R31 for an indication of 500 on the meter.

Step 4. Disconnect cable from TRIGGER INPUT on Cal-Control unit. Set TRIGGER selector 9S1 to INT position. Connect cable from VIDEO OUT on Cal-Control unit to VIDEO input on Display unit. Set 75 Ω switch on Display unit to OUT and VOLTS/IN switch to 20. Set METER SELECT switch on Calibration-Control unit to CAL and VIDEO OUT switch to 50. Set CAL ADJ (FULL SCALE) control 9R45 to mid-rotation.

Check for full scale deflection on the meter. If necessary, adjust CAL ADJ control 9R36 for full scale deflection. Make the following control settings on the Crystal Mark and Sync unit:

Control	Setting
TRIGGER DELAY	0
SWEEP DELAY	1-11
INTENSITY MARKS	1 & .1

Measure the following:

Pulse amplitude	50 volts ±1.5 v
Pulse duration	2.5 ±0.5 μsec
Rise Time	0.2 μsec max
Decay Time	0.5 μsec max
Overshoot	10% of pulse amplitude max

Table 5-11. Calibration-Control Unit Output Pulse Characteristics

VIDEO OUT SETTING*	10	5	2	1
Volts	10 ±0.3	5 ±0.15	2 ±0.06	1 ±0.03
Rise Time	0.11 μsec max	0.07 μsec max		
Decay Time	0.2 μsec max	0.11 μsec max		
Pulse Duration	2.5 ±0.5 μsec			
Overshoot	10% max			

*Set VOLTS/IN switch for usable vertical deflection for each step.

Step 5. Repeat measurements of step 4 for following settings of VIDEO OUT switch (in each setting readjust CAL ADJ (FULL SCALE) control for a full scale indication on the meter).

Step 6. Connect output of external signal generator to LP IN connector. Set TRIGGER Selector 9S1 to DEMOD position and VIDEO OUT Selector 9S2 to POWER position. Set signal generator to a frequency between 925 and 1225 mHz modulated at approximately 400 pps. Check for pulse on screen of Display unit.

Step 7. Set VIDEO OUT Selector to SHAPE position. Check for well-shaped pulse on screen of Display unit.

i. TESTING AND CALIBRATING RF OSCILLATOR.

1. TESTING RF OSCILLATOR. - To test the assembled rf oscillator, proceed as follows:

Step 1. Turn tuning shaft from stop-to-stop. It should turn without binding through the entire range (a minimum of 22 full turns).

Step 2. Check torque required to turn shaft both ways. Torque should be not less than 15 inch-ounces and not greater than 20 inch-ounces.

Step 3. Turn tuning shaft 20 times from stop-to-stop. Recheck torque. Torque shall be within 10% of reading obtained in step 2. If torque is not acceptable, readjust backlash nut (figure 5-5, item 39) by gaining access to its setscrew (item 40) through hole covered by screw (item 50). Operate the assembly from stop-to-stop three times in each direction and recheck torque.

Step 4. Check shaft for end play by pulling and pushing.

Step 5. Remove cap (item 1), retainer ring (item 2), and tube 8V2 (item 3). Measure resistance from center contact of capacitor 8C9 (item 49) to ground. It should be infinite.

Step 6. Measure resistance from center contact of capacitor 8C5 (item 23) to ground. It should be infinite.

Step 7. Apply 400 vdc between center contact of capacitor 8C5 (item 23) and housing for one minute, then repeat step 6.

Step 8. Measure resistance between center contact of capacitor 8C5 (item 23) and contact ring (item 7). It should be 15 ohms ±5%.

Step 9. Install tube 8V2 (item 3) and measure resistance from center contact of capacitor 8C9 (item 49) to ground. It should be between 1.5 and 2.5 ohms. Replace retainer ring (item 2) and tube 8V2 (item 3).

Step 10. Connect rf oscillator assembly to an operating Radar Test Set AN/UPM-98A and external test equipment as shown in figure 5-12.

Step 11. Adjust Radar Test Set AN/UPM-98A for Mode 3/A interrogation at a prf rate of 1000.

Step 12. Turn rf oscillator tuning shaft fully clockwise. Measure oscillator frequency at this position. Frequency should be above 1235 mHz.

Step 13. Turn rf oscillator tuning shaft fully counterclockwise. Measure frequency. It should be below 910 mHz.

Step 14. Set rf oscillator frequency to 920 mHz and measure the following:

Function	Measured On	Acceptacle Reading
Power Output	Power Meter	-21 db min
Delay start of oscillation	Oscilloscope	0.3 μsec max
Rise Time	Oscilloscope	0.07 μsec max

Step 15. Tune rf oscillator through range and observe output on oscilloscope. There

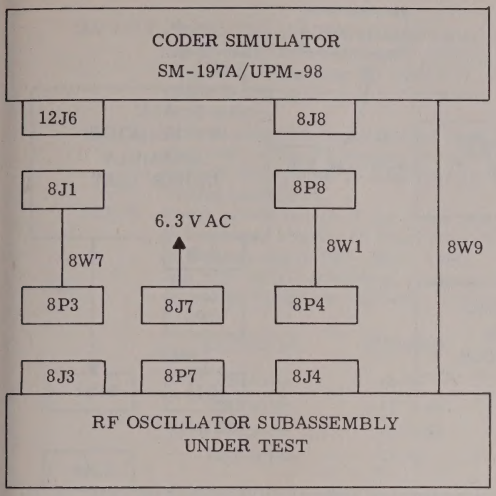


Figure 5-12. RF Oscillator Assembly 8A1, Test Setup

should be no appreciable change in size and shape of output pulse, or excessive pulse jitter.

Step 16. Set Radar Test Set AN/UPM-98A for modulation of rf oscillator with SIF Code number 0000 and pulse width of 0.45 μsec. Adjust rf oscillator to 1075 mHz.

Step 17. While observing the last bracket pulse in the train, switch SIF Coder to 7777 one switch step at a time. During all this switching the last pulse should not shift more than 0.05 μsec.

Step 18. Observe pulses D4 and B4. Using SUB PULSE POS control on SIF coder, delay pulse D4 to a point just before it merges with pulse B4 into a single pulse. Measure spacing between leading edges of the two pulses. It should be not more than 1.0 μsec.

2. CALIBRATING RF OSCILLATOR.

Step 1. Set WAVEMETER FREQUENCY control to 920 mHz using Wavemeter Calibration Curve.

Step 2. Set WAVEMETER INPUT switch to SIG GEN position and METER SELECT switch to WM.

Step 3. Turn SG FREQUENCY crank for maximum dip on meter, adjusting WM SENS control as required to obtain meter deflection of approximately 75% of full scale.

Step 4. Adjust rf oscillator counter to indicate 0000 and fasten setscrews.

Step 5. Record counter readings at 920, 950, 1000, 1050, 1100, 1150, 1200, and 1230 mHz. Correct oscillator calibrator curve accordingly.

j. TESTING AND CALIBRATING ALC/ATTENUATOR ASSEMBLY.

1. TESTING ALC/ATTENUATOR. - To test the assembled ALC/Attenuator, proceed as follows:

Step 1. Check resistance between center contact of capacitor 8C1 (figure 5-6, item 3) and ground. Resistance should be 0.5 to 1.5 ohms.

Step 2. Check resistance between center pin of SG OUT connector (item 34) and ground. It should be 47 ohms $\pm$5%.

Step 3. Check resistance between center contact of capacitor 8C4 (item 21) and ground. Resistance should be infinite.

Step 4. Check resistance between center contact of capacitor 8C4 (item 21) and center conductor of rf cable (item 10). Resistance should be 15 ohms $\pm$5%.

Step 5. Measure VSWR at SG OUT connector (item 34) by connecting ALC/Attenuator to test equipment as shown in figure 5-13. With attenuator plunger in center of its travel range, VSWR should be less than 1.18:1 (1.4 db) over a frequency range from 925 to 1225 mc.

2. CALIBRATING ALC/ATTENUATOR ASSEMBLY.

Step 1. Set internal modulation of Radar Test Set with Mode 3/A interrogation at prf of approximately 2000 pps. Set OPER-CHECK switch 9S4 on rear of Calibration-Control unit chassis to CHECK position. Set VIDEO OUT switch to SG MON. Connect VIDEO OUT to VIDEO input connector on Display unit.

Step 2. Observe demodulated rf output pulse on oscilloscope tube. Turn SG FREQUENCY control from its full counterclockwise position to full clockwise position while continuously observing pulse amplitude. Note dial setting which gives lowest pulse amplitude. After reaching end of clockwise travel, return shaft to point of lowest pulse amplitude. Record that amplitude figure.

Step 3. Set OPER-CHECK switch to OPER position and adjust ALC ADJ internal control 9R3 on other side of chassis for same pulse amplitude as recorded in step 2. Check to see that pulse amplitude now is constant through the entire frequency range. Return setting to approximately 1050 mHz.

Step 4. Connect test equipment as shown in figure 5-14. Set TS-1253A for external triggering. Tune SG FREQUENCY to approximately 1050 mHz and set ATTENUATION control so that RF Power Meter indicates a power output

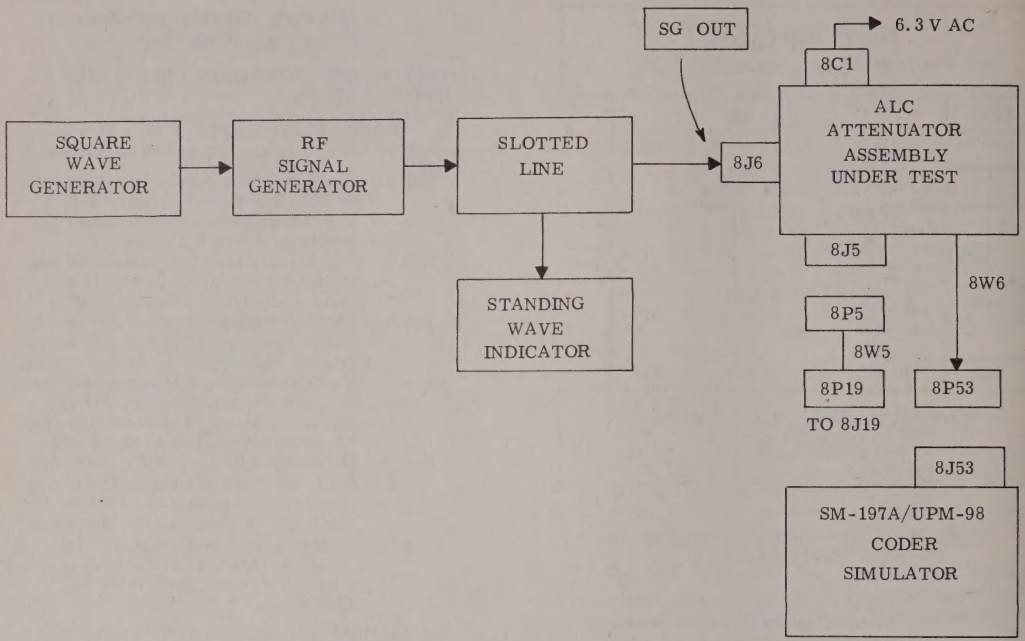


Figure 5-13. ALC/Attenuator Assembly 8A2, Test Setup

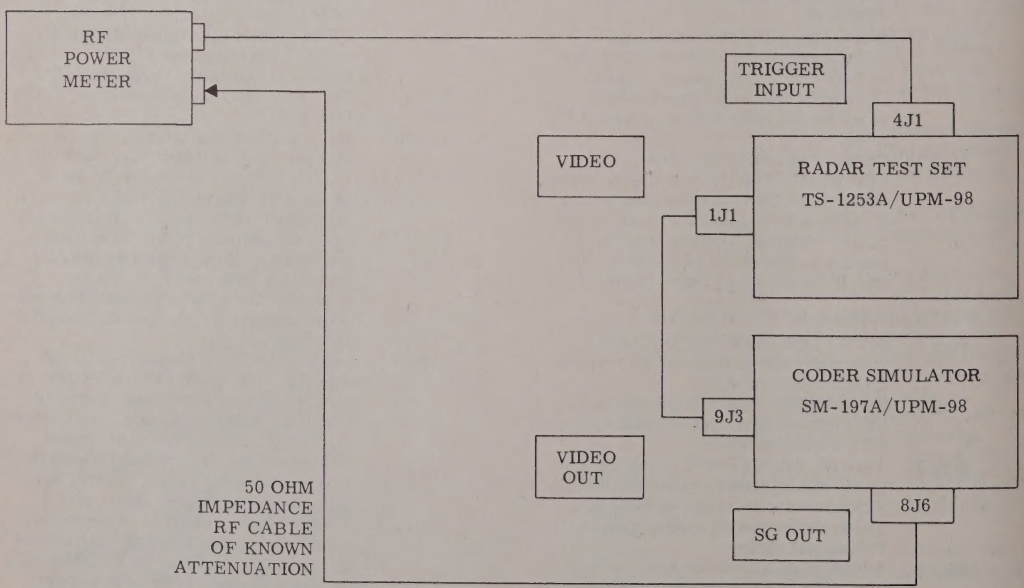


Figure 5-14. ALC/Attenuator 8A2, Calibration Test Setup

of -8.3 dbm plus the attenuation of the rf cable assembly used. (Attenuation of a 5 ft. long RG-223/U rf cable is approximately 1.1 dbm at 1050 mHz).

Step 5. Loosen setscrew on attenuator shaft gear and, without changing attenuator setting, set counter to indicate 021.0. Fasten setscrews.

Step 6. Check power output of set under test in a manner similar to steps 4 and 5 at frequencies of 925, 1030, 1090, and 1225 mHz. Attenuator accuracy should be within the following limits:

Frequency	Accuracy
925 mHz	±3 db
1030 mHz	±1.5 db
1090 mHz	±1.5 db
1225 mHz	±3 db

k. TESTING AND CALIBRATING WAVEMETER ASSEMBLY.

1. TESTING WAVEMETER ASSEMBLY. - To test the assembled wavemeter assembly, proceed as follows:

Step 1. Remove cover (figure 5-7, item 25) and inspect interior of the cavity. Walls and tuning stub should be polished to a mirror finish without any scratches.

Step 2. Turn tuning shaft throughout its travel range. The shaft should make not less than 26 complete turns in both directions without binding, using a torque between 12 and 20 inch-ounces.

Step 3. Turn tuning shaft 20 times from stop-to-stop. Recheck torque. The torque should be within 10% of the reading obtained in step 2. If torque is not acceptable, readjust backlash nut (figure 5-7, item 11) through opening in housing. Operate the tuning shaft three times between stops and again check torque.

Step 4. Check shaft for end play. There should be no noticeable end play with either a 10 lb pressure or pull on the shaft.

Step 5. With cover (figure 5-7, item 25) removed, check that both coupling loops are in line with the axis of the tuning stud. The tops of the loops should just be seen within the cavity. Replace cover.

Step 6. Connect wavemeter assembly to Radar Test Set AN/UPM-98A and external test equipment as shown in figure 5-15.

Step 7. Adjust signal generator for a 0.5 μsec wide pulse at prf of 47 pps and 150 millivolts peak output at approximately 1050 mHz.

Step 8. Set METER SELECT control on Radar Test Set AN/UPM-98A to WM. Set WM SENS control to maximum clockwise position. Turn wavemeter tuning shaft until AN/UPM-98A meter needle dips, indicating resonance. Meter needle should drop to less than 50% of scale at maximum resonance point.

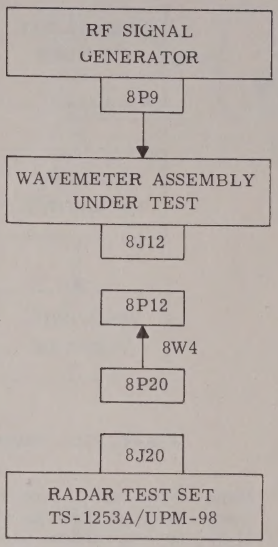


Figure 5-15. Wavemeter Assembly 8A3, Test Setup

Step 9. Alternately apply approximately 10 lbs of pressure and pull on wavemeter shaft and check for any difference in meter indication. Indication of step 8 should not change more than 25% and it should return to within 5% of original indication.

Step 10. Turn wavemeter tuning shaft maximum clockwise. Tune signal generator until AN/UPM-98A meter needle dips. This frequency should be 1240 mHz or more.

2. CALIBRATING WAVEMETER ASSEMBLY.

Step 1. Connect Radar Test Set AN/UPM-98A and test equipment as shown in figure 5-16. For this procedure set POWER switch on SM-197A/UPM-98 in OFF position.

Step 2. Set signal generator to 900 mHz at average power output of approximately zero dbm.

Step 3. Tune wavemeter for a peak indication on milliammeter.

Step 4. Using frequency counter, tune transfer oscillator to exactly 150 mHz.

Step 5. Tune signal generator to produce a near-zero beat indication on the transfer oscillator oscilloscope.

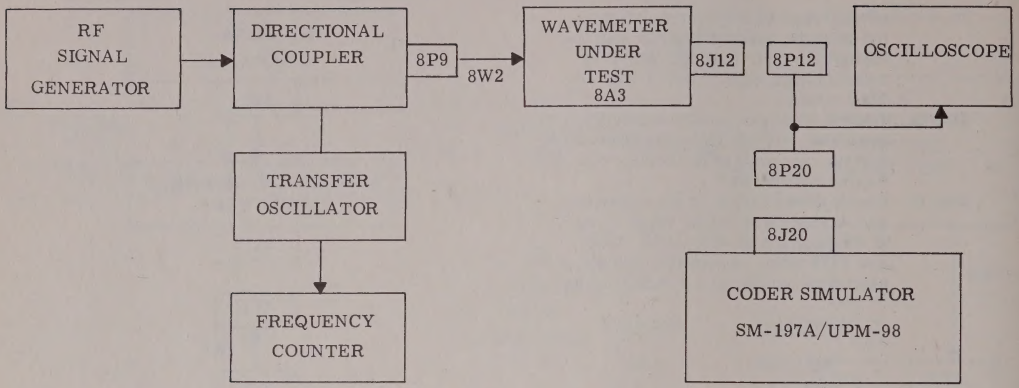


Figure 5-16. Wavemeter Assembly 8A3, Calibration Test Setup

Make certain that the beat indication observed is with the sixth harmonic of the 150 mHz transfer oscillator signal.

Step 6. Use fine frequency vernier control of the transfer oscillator to obtain a true zero beat indication.

Step 7. Carefully tune wavemeter for maximum indication on the milliammeter.

Step 8. Record wavemeter dial indication and transfer oscillator frequency.

Step 9. Calculate exact signal generator frequency by multiplying transfer oscillator frequency by six. Record this frequency.

Step 10. Repeat steps 4 through 9 with all transfer oscillator frequencies given in table 5-12.

Step 11. If necessary, plot new wavemeter calibration curves similar to those given in pages 1 through 9 of Book of Calibration Charts, using figures given in table 5-12.

1. TESTING AND CALIBRATING DEMODULATOR ASSEMBLY.

1. TESTING DEMODULATOR ASSEMBLY. - To test assembled demodulator, proceed as follows:

Step 1. Check resistance between following points:

Test Point	Acceptable Reading
SG IN connector to ground	20 ohms ±10%
SG IN connector to LP IN connector	infinite
SG IN connector to HP IN connector	less than 0.5 ohm
SG IN connector to 8J11 connector	22 ohms ±10%
LP IN connector to ground	infinite
LP IN connector to HP IN connector	infinite
LP IN connector to 8J11 connector	infinite
HP IN connector to ground	20 ohms ±10%
HP IN connector to 8J11 connector	25 ohms ±10%
Terminal stud (figure 5-8, item 17) to ground	infinite
Center of 8C14 (figure 5-8, item 26) to ground	0.5 to 1.5 ohms

Table 5-12. Wavemeter Frequency Calibration Settings

NOMINAL SG FREQ	NOMINAL TRANS OSC FREQ	NOMINAL SG FREQ	NOMINAL TRANS OSC FREQ
900	150.000	1080	180.000
910	151.667	1090	181.667
920	153.333	1100	183.333
930	155.000	1110	185.000
940	156.667	1120	186.667
950	158.333	1130	188.333
960	160.000	1140	190.000
970	161.667	1150	191.667
980	163.333	1160	193.333
990	165.000	1170	195.000
1000	166.667	1180	196.667
1010	168.333	1190	198.333
1020	170.000	1200	200.000
1030	171.667	1210	201.667
1040	173.333	1220	203.333
1050	175.000	1230	205.000
1060	176.667	1240	206.667
1070	178.333	1250	208.333

Step 2. Connect demodulator and test equipment as shown in figure 5-17. Check VSWR alignment of SG IN, LP IN, and HP IN connectors with signal frequencies from 900 to 1250 mHz at 50 mHz intervals. Make certain that unused connectors are terminated with a 50-ohm dummy load. VSWR of all connectors at all frequencies should be less than 1.4:1 (3.0 db).

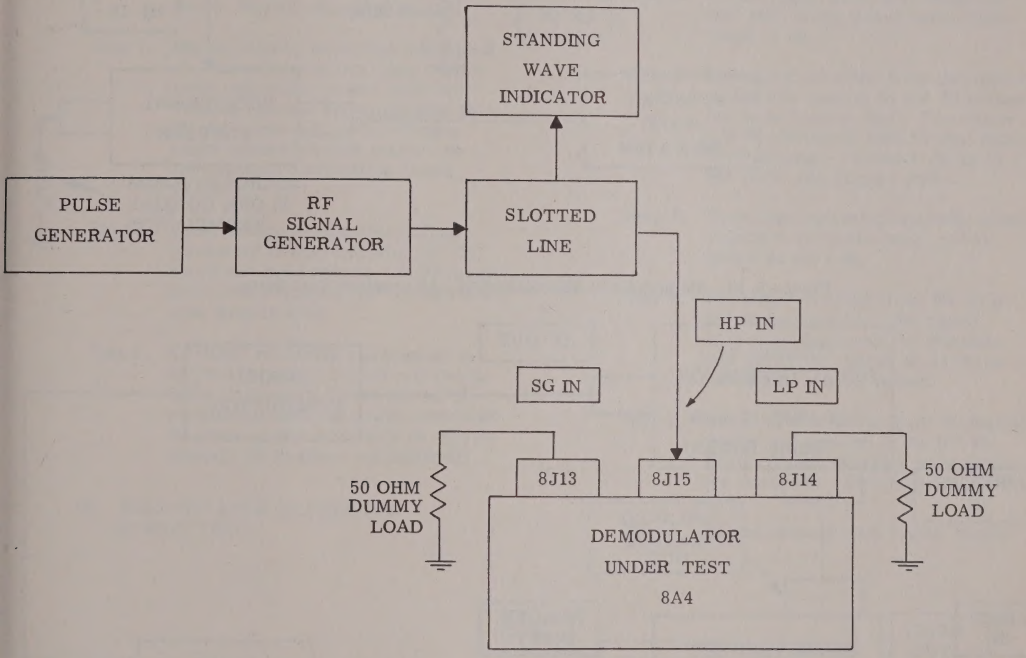


Figure 5-17. Demodulator Assembly 8A4, VSWR Test Setup

Step 3. Connect demodulator and test equipment as shown in figure 5-18. Set prf of pulse generator to 1000 pps. Set signal generator to 1050 mHz at a power output level which provides a convenient reading without pulse jitter on the standing wave indicator.

Step 4. Record power level of signal generator output and the reading on standing wave indicator.

Step 5. Disconnect cables from SG IN and HP IN connectors on demodulator and join them using connector adapter UG-914/U. Adjust signal generator for an indication on standing wave meter the same as that recorded in step 4. Subtract reading of step 4 from reading of step 5. Result is demodulator attenuation between connectors SG IN and HP IN. It should be between 11.5 and 4.5 db.

Step 6. Connect signal generator output to SG IN and directional coupler input to LP IN on demodulator. Terminate HP IN connector with a 50-ohm load. Repeat steps 4 and 5. Result is the attenuation between DEMODULATOR SG IN and LP IN connectors. The attenuation should be between 35 and 39 db.

2. CALIBRATING DEMODULATOR ASSEMBLY.

Step 1. Connect Radar Test Set AN/UPM-98A and test equipment as shown in figure 5-19.

Step 2. Set signal generator output for 1075 mHz at a power level between 3900 and 3500 watts (approximately 36 db above one milliwatt). If necessary, use rf attenuator pad to reduce power output.

Step 3. Set VIDEO OUT switch on Calibration-Control unit to POWER position. Accurately measure and record amplitude (in volts) of the pulse on Display unit oscilloscope.

Step 4. Disconnect rf cable from HP IN connector on Coder Simulator SM-197A/UPM-98 under test and connect it to RF IN receptacle of pulse power calibrator. Accurately measure and

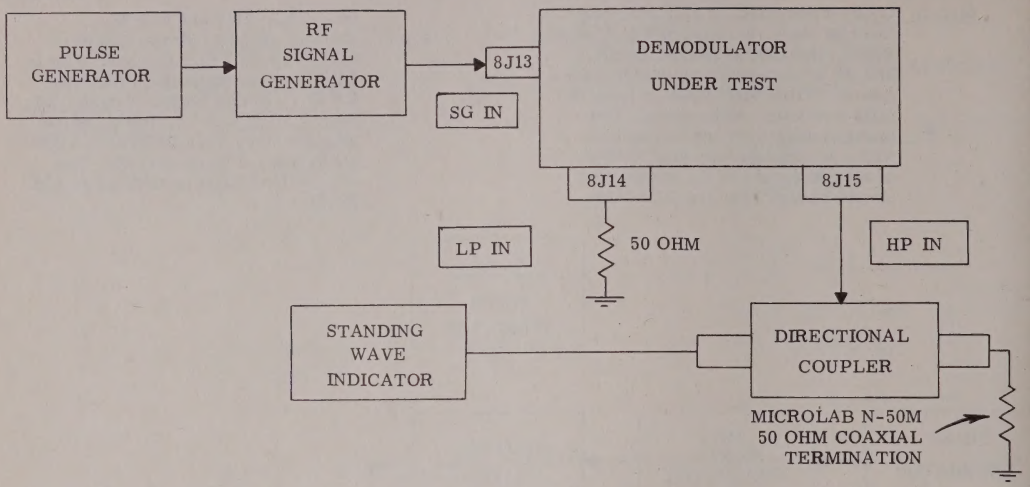


Figure 5-18. Demodulator Assembly 8A4, Attenuation Test Setup

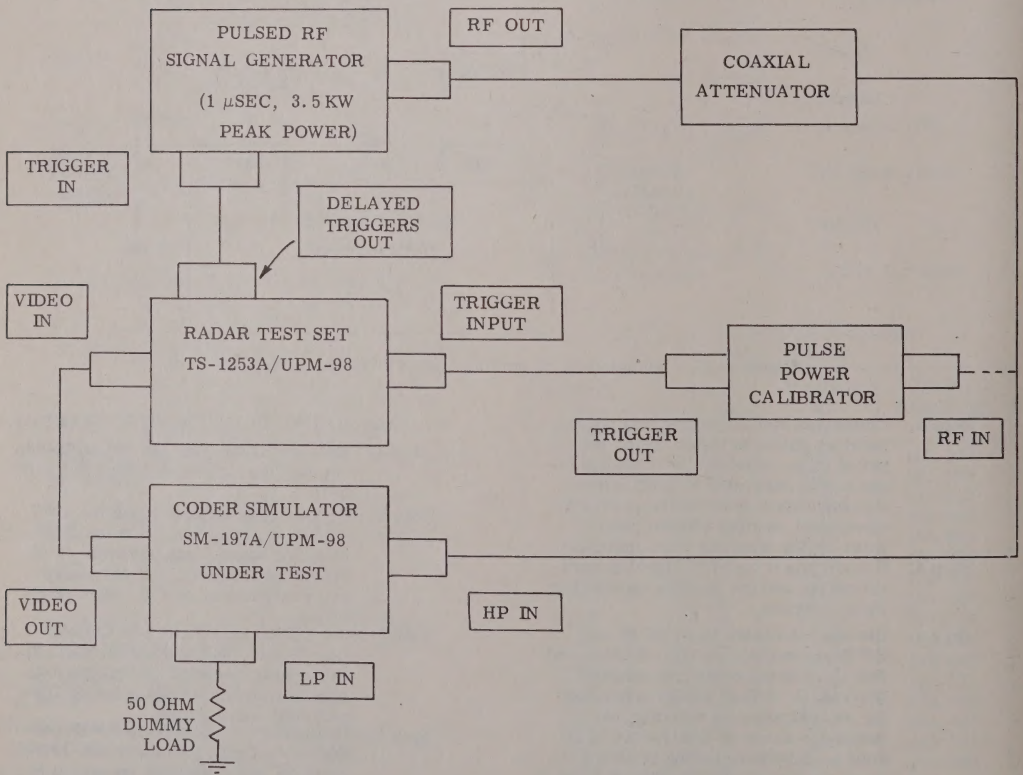


Figure 5-19. Demodulator Assembly 8A4, Calibration Test Equipment Setup

record rf power in dbm.

Step 5. Mark a dot on volts and power coordinate crossover point on Demodulator Calibration Curve Chart for HP IN receptacle on page 2 of Book of Calibration Charts supplied with the equipment under test.

Step 6. Add a 3 db attenuator pad between signal generator output and test set input. Repeat steps 3 through 5.

Step 7. Repeat step 6, each time adding a 3 db attenuator and recording output level until pulse power calibrator reading reaches approximately 46 db above one milliwatt. Draw a curve across all dots marked on Demodulator Calibration Curve Chart.

Step 8. Connect signal generator output attenuated to approximately 46 db above one milliwatt to LP IN receptacle and terminate HP IN with a 50 ohm dummy load.

Step 9. Continue recording readings as in steps 3 through 7 to plot a Demodulator Calibration Curve for LP IN receptacle until the power measured on pulse power calibrator is approximately 27 db above one milliwatt.

(3) DEMODULATOR FREQUENCY CORRECTION.

Step 1. Connect Radar Test Set AN/UPM-98A and test equipment as shown in figure 5-20.

Step 2. Turn gain control of standing wave indicator completely counterclockwise. Set signal generator for a frequency of 925 mHz, square wave modulated at 1 kHz.

Step 3. Adjust signal generator output so that microwave power meter indicates +3 db.

Step 4. Disconnect rf cable from thermistor mount and connect to HP IN connector on unit under test. Terminate LP IN connector with 50 ohm dummy load plug. Connect SG IN to SG OUT with jumper cable.

Step 5. Turn gain control of standing wave indicator clockwise until meter indicates zero db.

Step 6. Reconnect rf cable from HP IN to thermistor mount. Set signal generator frequency to 950 mHz and adjust its output to +3 db on microwave power meter.

Step 7. Disconnect rf cable from thermistor mount and connect it to HP IN. Do not touch standing wave indicator controls. Record meter indication.

Step 8. Repeat steps 6 and 7 with signal

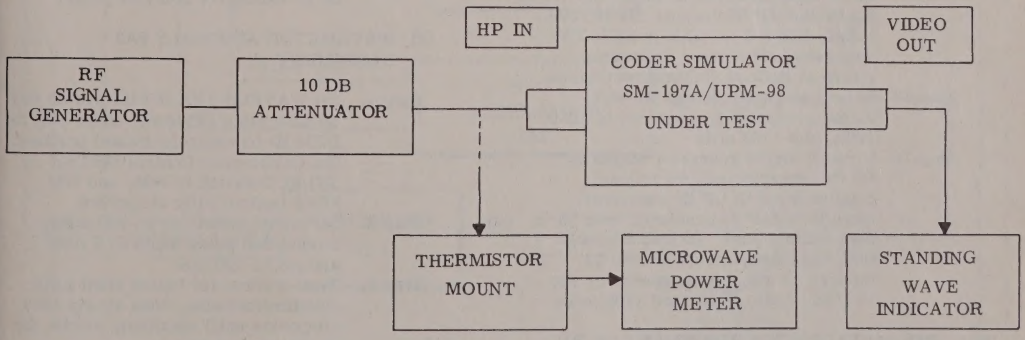


Figure 5-20. Demodulator Assembly 8A4, Frequency Correction Test Equipment Setup

generator frequencies of 975, 1000, 1025, 1050, 1075, 1100, 1125, 1150, 1175, 1200, and 1225 mHz.

Step 9. Add reading obtained at 1075 mHz frequency to all readings recorded in steps 7 and 8. This will provide the demodulation frequency correction, which will be zero at 1075 mHz, negative at lower frequencies, and positive above 1075 mHz. Correct accordingly the correction chart printed underneath the Demodulator Calibration Curve for the HP IN connector.

Step 10. Repeat step 4 through 9 with rf signal input to LP IN connector and correct Demodulator Calibration Curve for LP IN connector correction chart.

Step 11. Connect AN/UPM-98A and test equipment as shown in figure 5-18 for demodulator attenuation test. Set prf of square wave generator to 1000 Hz.

Step 12. Set signal generator frequency to 1020 mHz at a power level which provides convenient reading without pulse jitter on standing wave indicator.

Step 13. Record power level of signal generator output and reading on standing wave indicator.

Step 14. Disconnect cables from SG IN and HP IN connectors and join them using connector adapter UG-914/U. Adjust signal generator to provide an indication on standing wave indicator identical to the one recorded in step 13. Subtract signal generator power reading obtained in step 13 from reading of step 14. Result is demodulator attenuation constant between SG IN and HP IN receptacles at 1020 mHz. Enter it on table printed underneath Oscillator Calibration Curve in Book of Calibration Charts.

Step 15. Repeat steps 12 through 14 with signal generator frequencies of 1030, 1090, and 1100 mHz.

Step 16. Connect signal generator output to SG IN connector and directional coupler input to LP IN connector. Terminate HP IN connector with 50 ohm dummy load. Repeat attenuation measurements as in step 12 through 15 with signal generator set to 1020, 1030, 1090, and 1100 mHz.

m. PRE-INSTALLATION ALIGNMENT OF RF BASE PLATE ASSEMBLY.

(1) GENERAL. - When one or more of the three rf assemblies mounted on the base plate assembly of Coder Simulator SM-197A/UPM-98 is repaired or replaced, it is necessary to recalibrate and realign the unit. Connect equipment as in figure 5-21.

(2) RF OSCILLATOR ASSEMBLY 8A1 ALIGNMENT.

Step 1. Set the signal generator frequency to 925 mHz and the ATTENUATION control for maximum output.

Step 2. Set oscilloscope for display of input signal at input A. Check that the attenuator shaft is set to the full counterclockwise position.

Step 3. Set Radar Test Set AN/UPM-98A for an internal triggering prf of 1000 Hz, and rf oscillator modulated with mode 3/A interrogation.

Step 4. Turn rf oscillator tuning shaft counterclockwise to end of rotation, then start turning clockwise until zero-beat effect is observed on oscilloscope.

Step 5. Engage bevel gear (figure 5-9, item 11) and compound gear (item 16). Tighten setscrews (item 10). Rotate tuning shaft counterclockwise until the gear stops engage. The counter should now indicate 000. Readjust position of gears (items 14 and 16) if necessary, to have 000 indicated on counter when gear stops engage.

Step 6. Turn rf oscillator shaft fully clockwise. Obtain zero beat indication with the signal generator to check that oscillator frequency is above 1250 mHz.

Step 7. Turn signal generator off; set oscilloscope for alternate display of traces at inputs A and B.

Step 8. Compare modulation pulses and detected rf pulses appearing on oscilloscope. They should not differ appreciably in shape and there should be no excessive delay or jitter.

(3) WAVEMETER ASSEMBLY 8A3 ALIGNMENT.

Step 1. Set WAVEMETER INPUT switch 8S1 on base plate assembly under test to DEMOD (counterclockwise) position. Set Calibration-Control METER SELECT switch to WM, and WM SENS control fully clockwise.

Step 2. Set signal generator to 900 mHz, modulation pulse width to 6 μsec, and prf to 400 pps.

Step 3. Turn wavemeter tuning shaft fully counterclockwise, then slowly turn clockwise until maximum needle dip is obtained on meter.

Step 4. Set wavemeter counter to indicate 0410. Engage bevel gear (figure 5-9, item 2) and compound gear (item 4). Loosen setscrews (item 5) and set gear stop so that counterclockwise travel of the tuning shaft is stopped when counter indicates 000. Tighten setscrews (items 3 and 5).

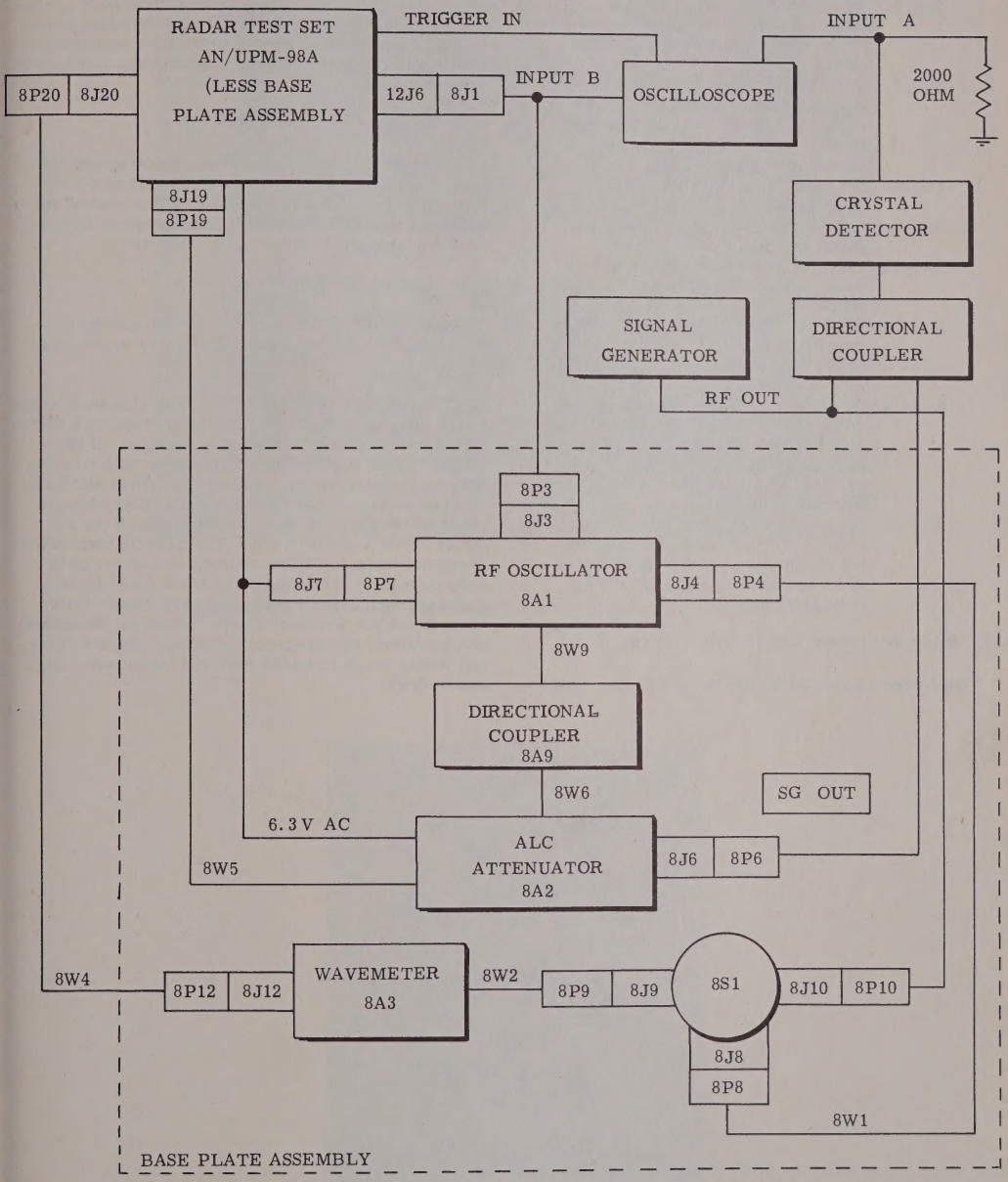


Figure 5-21. RF Base Plate Assembly, Pre-installation Alignment Setup

Step 5. Set signal generator frequency to 1250 mHz.

Step 6. Turn wavemeter shaft clockwise until maximum dip is obtained on meter. Counter dial should read approximately 2250.

Step 7. Turn shaft further clockwise to check that stops on gears engage before wavemeter shaft reaches end of its travel. At this point the counter should read above 2300.

Step 8. Set signal generator frequency to 1050 mHz.

Step 9. Adjust wavemeter tuning shaft for maximum dip of meter needle.

Step 10. Set wavemeter input switch 8S1 on base plate assembly in SIG GEN position.

Step 11. Set Radar Test Set AN/UPM-98A internal trigger prf to 47 pps, mode to 3/A, and WM SENS control maximum clockwise.

Step 12. Adjust rf oscillator tuning shaft for maximum dip of meter needle. Meter indication should be less than 50% of full scale. Adjust coupling loop of crystal 8CR1 to obtain a greater dip if it is not adequate.

Step 13. Apply Molycote lubricant (or equivalent) to all gear teeth. Operate tuning mechanisms so that lubricant is well distributed. Wipe off any excess lubricant.

5-6. REPLACEMENT PARTS STANDARDS.

There are no special minimum acceptable standards for selecting replacement parts during maintenance of Radar Test Set AN/UPM-98A. Usually, standard stock items will provide satisfactory operation of the test set. Applicable electron tubes should be replaced when successive preventive maintenance check-off readings gradually approach the lower limit of performance.

5-7. SCHEMATIC DIAGRAMS.

Schematic diagrams for troubleshooting and circuit tracing purposes are provided in figures 5-57 through 5-67. Refer to section 4 of this manual for voltage and resistance charts and waveform illustrations for significant points in the test set.

5-8. PARTS LOCATION.

Figures 5-22 through 5-56 are photographs and drawings showing the locations of parts in the equipment.

5-9. CLEANING AIR FILTER. - The aluminum mesh air intake filter should be cleaned at least once every month under normal operating conditions. If the equipment is operated in environments with a higher than normal dust or dirt content, the filter should be checked more often. To remove the filter element, unscrew the eight machine screws holding the air intake cover and pull it out. The filter is then easily removed. Wash the filter element in a warm mild soap solution. After cleaning, allow filter to dry, then coat with filter coating adhesive (Super Filter Coat; Research Products Corp., Madison, Wisconsin or equivalent) by spraying or dipping. Return filter and intake cover to intake port and fasten with original screws.

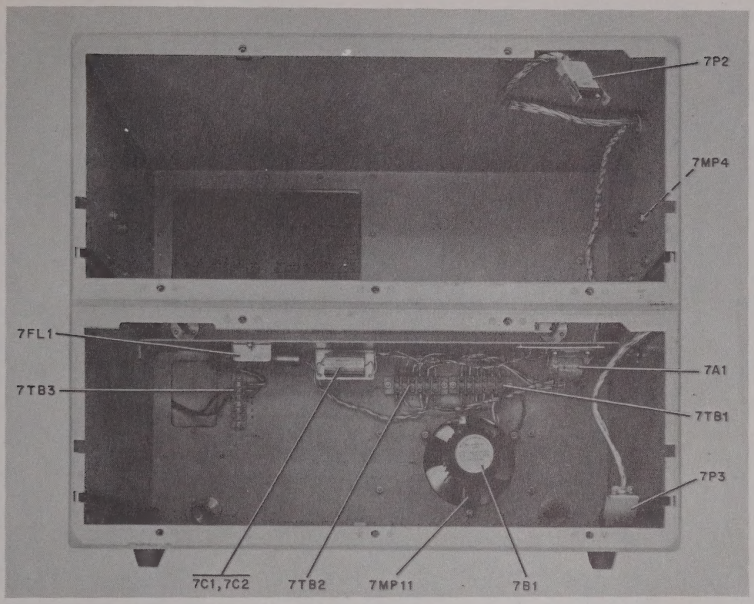
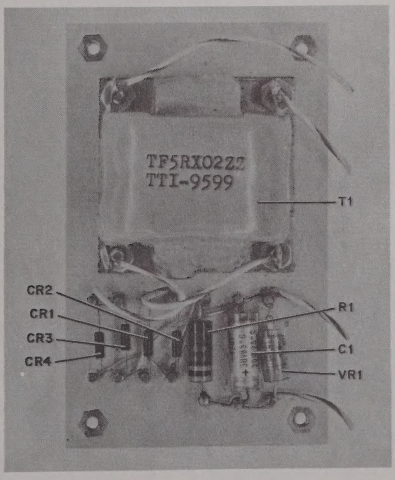


Figure 5-22. Electrical Equipment Case CY-2726A/UPM, Parts Location



REF DESIG PREFIX 7A1

Figure 5-23. Elapsed Time Meter Power Supply 7A1, Parts Location

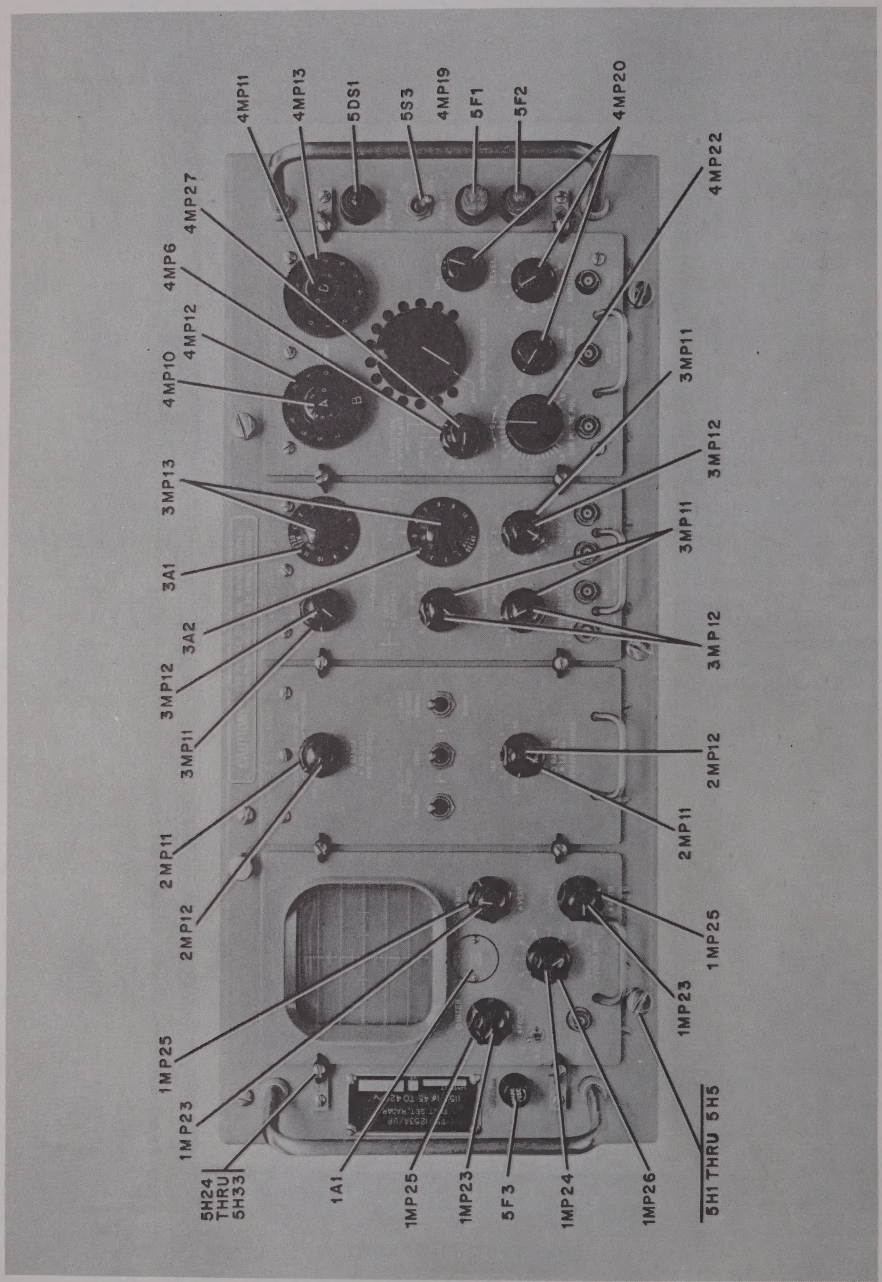
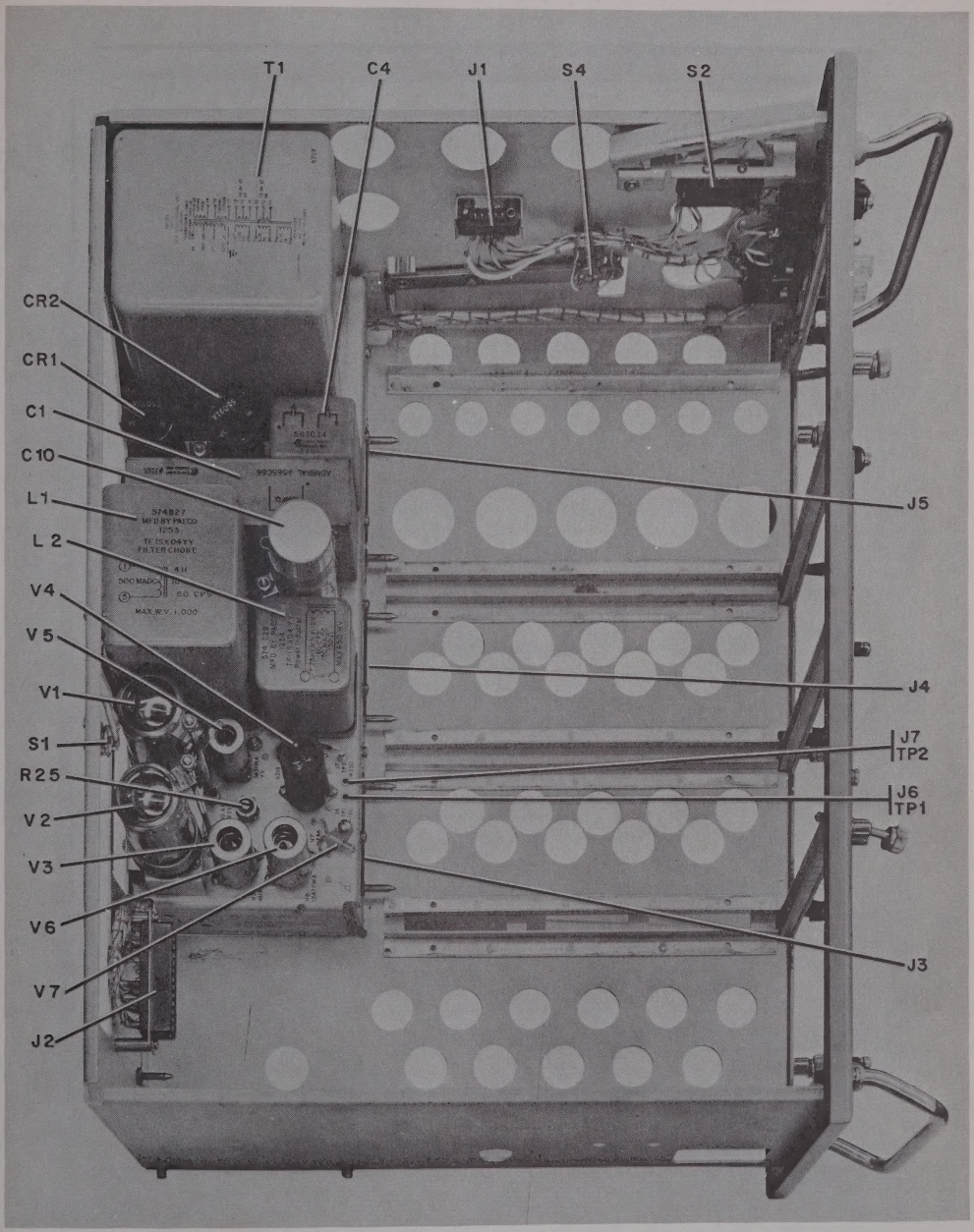
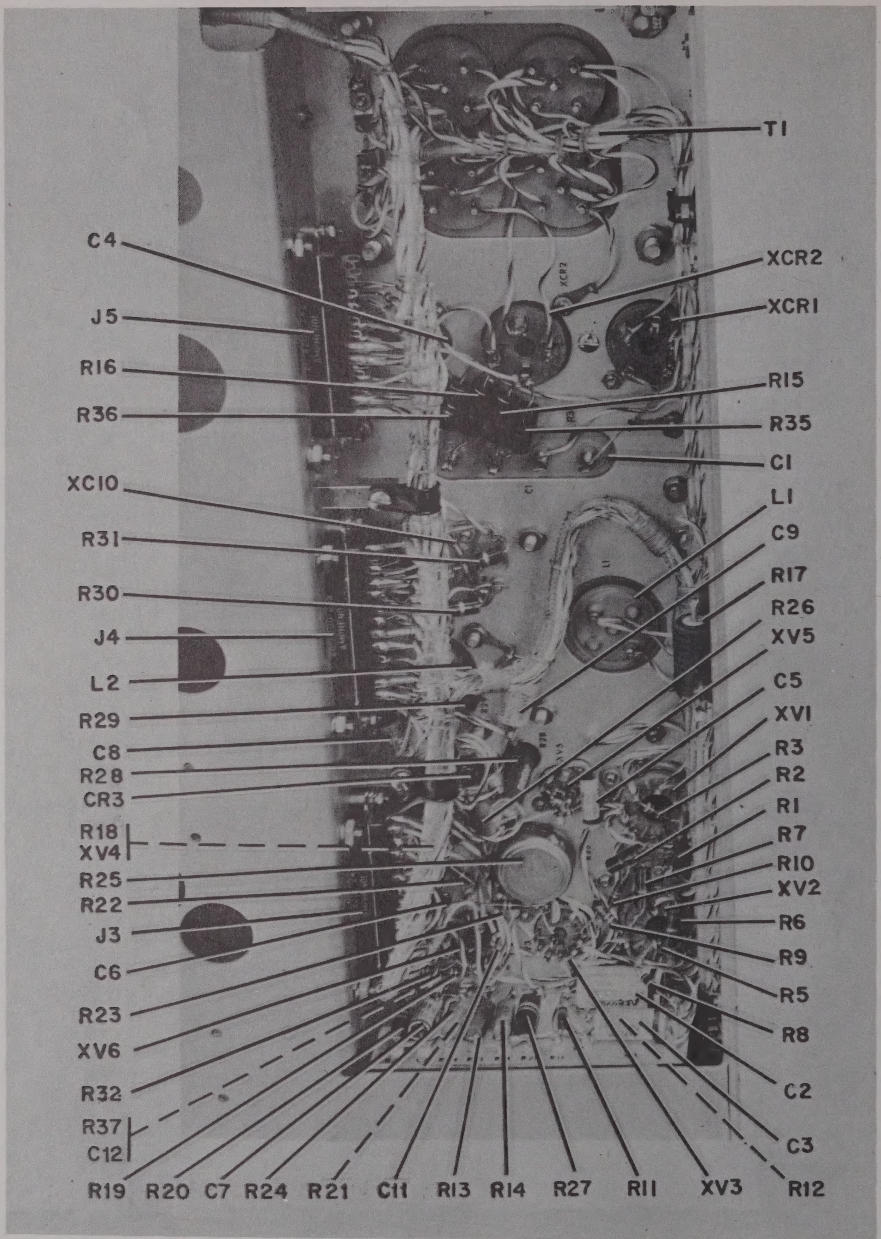


Figure 5-24. TS-1253A/UP, Front View, Parts Location



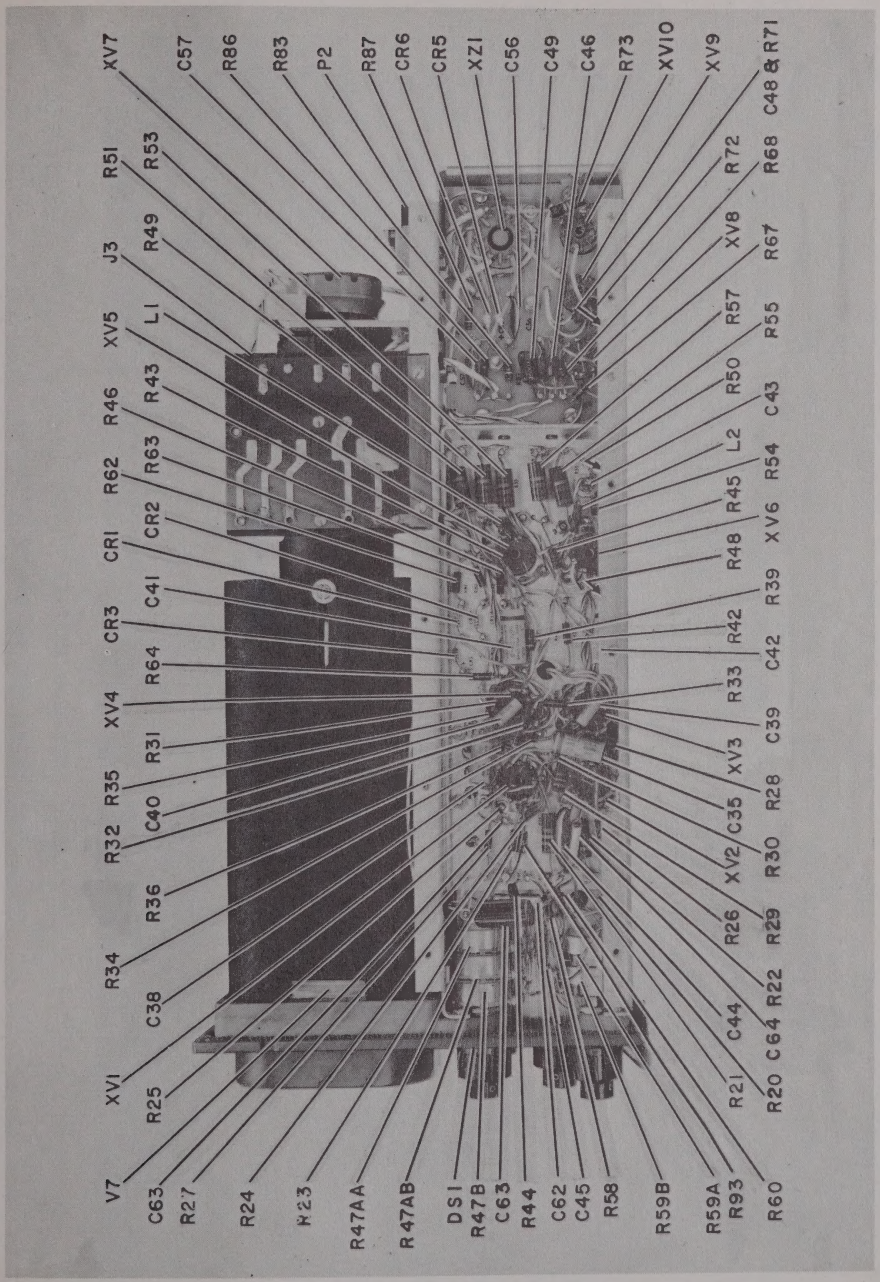
REF DESIG PREFIX 5

Figure 5-25. TS-1253A/UP, Panel-Chassis, Top, Parts Location



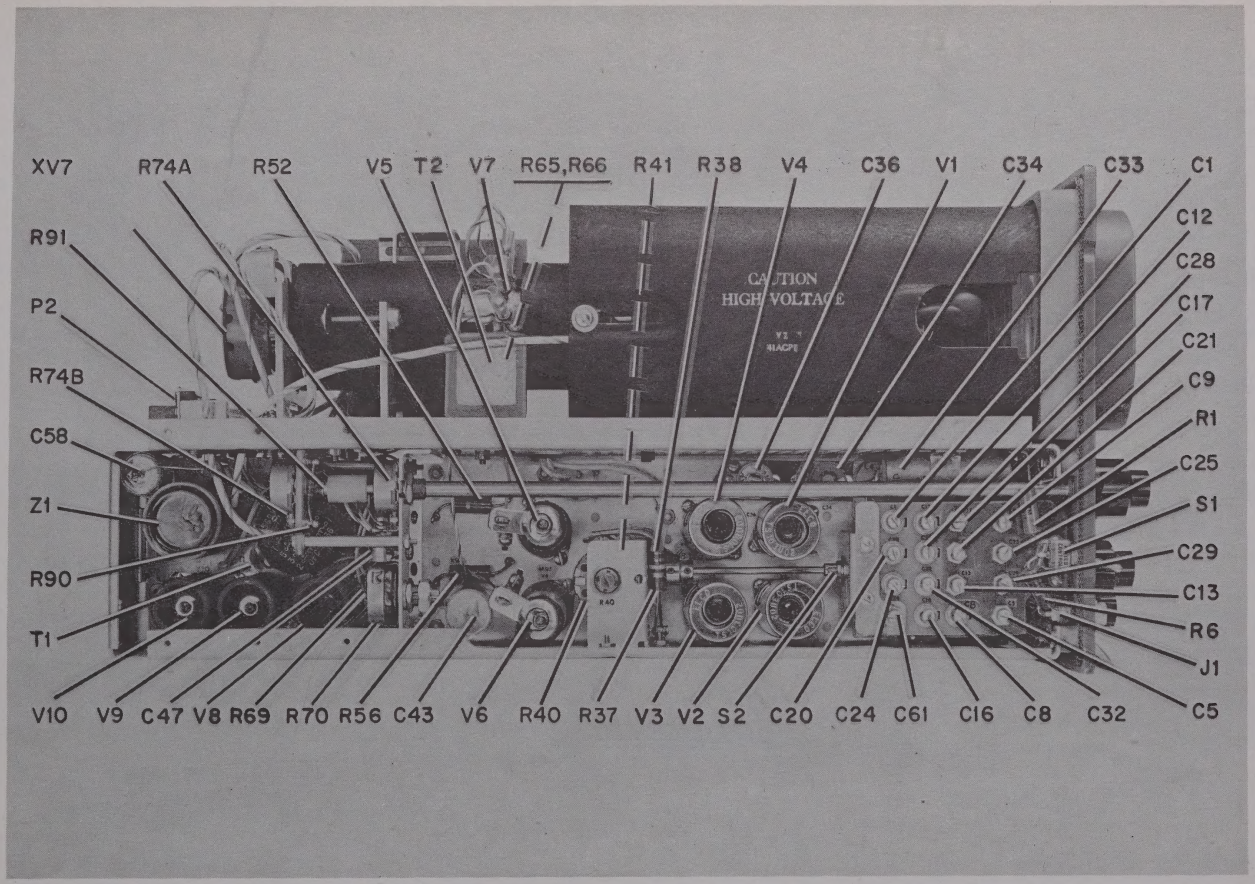
REF DESIG PREFIX 5

Figure 5-26. TS-1253A/UP, Panel-Chassis, Bottom, Parts Location



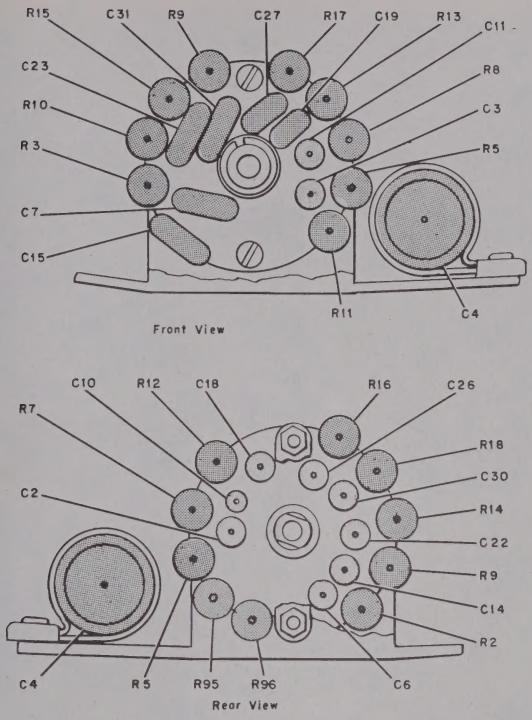
REF DESIG PREFIX 1

Figure 5-27. Display Unit, Right Side, Parts Location



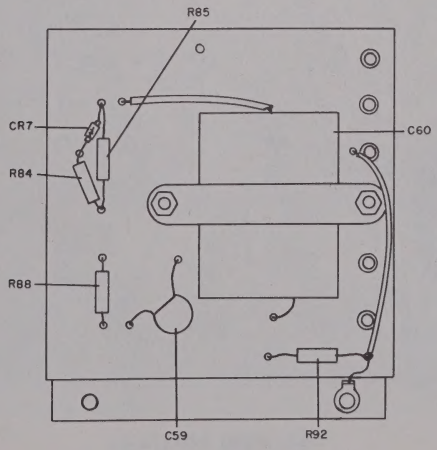
REF DESIG PREFIX 1

Figure 5-28. Display Unit, Left Side, Parts Location



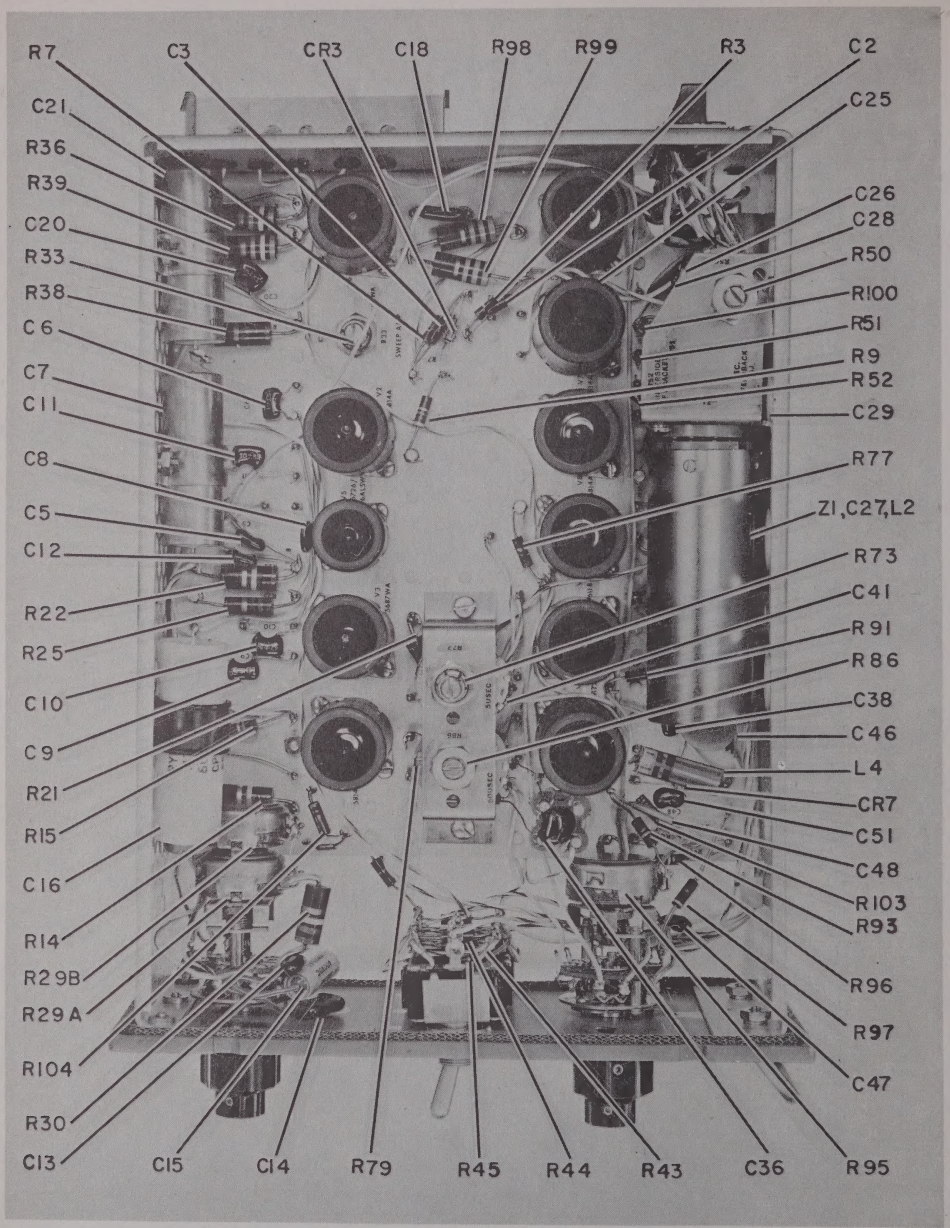
REF DESIG PREFIX 1

Figure 5-29. Display Unit, Video Attenuator Assembly, Parts Location



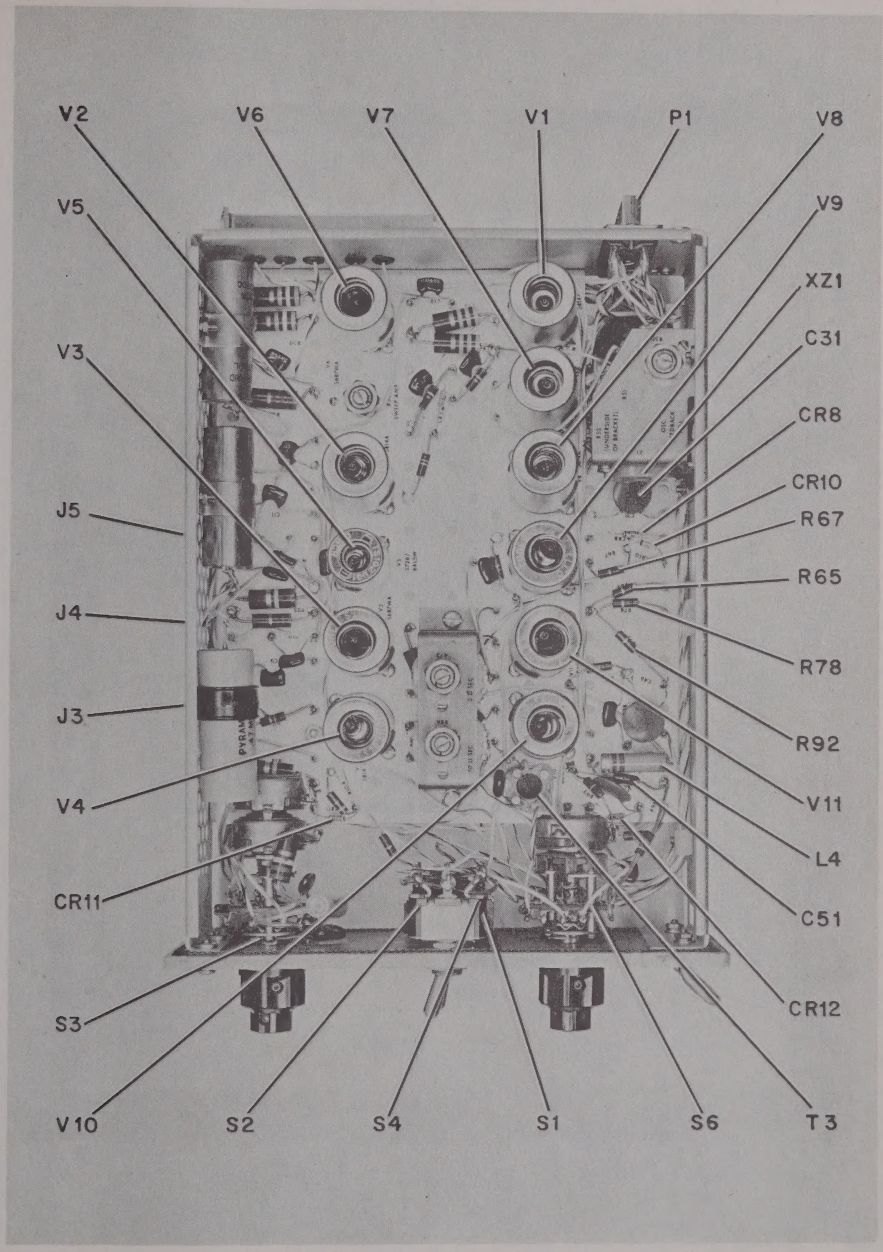
REF DESIG PREFIX 1

Figure 5-30. Display Unit, Contact Plate Assembly, Parts Location



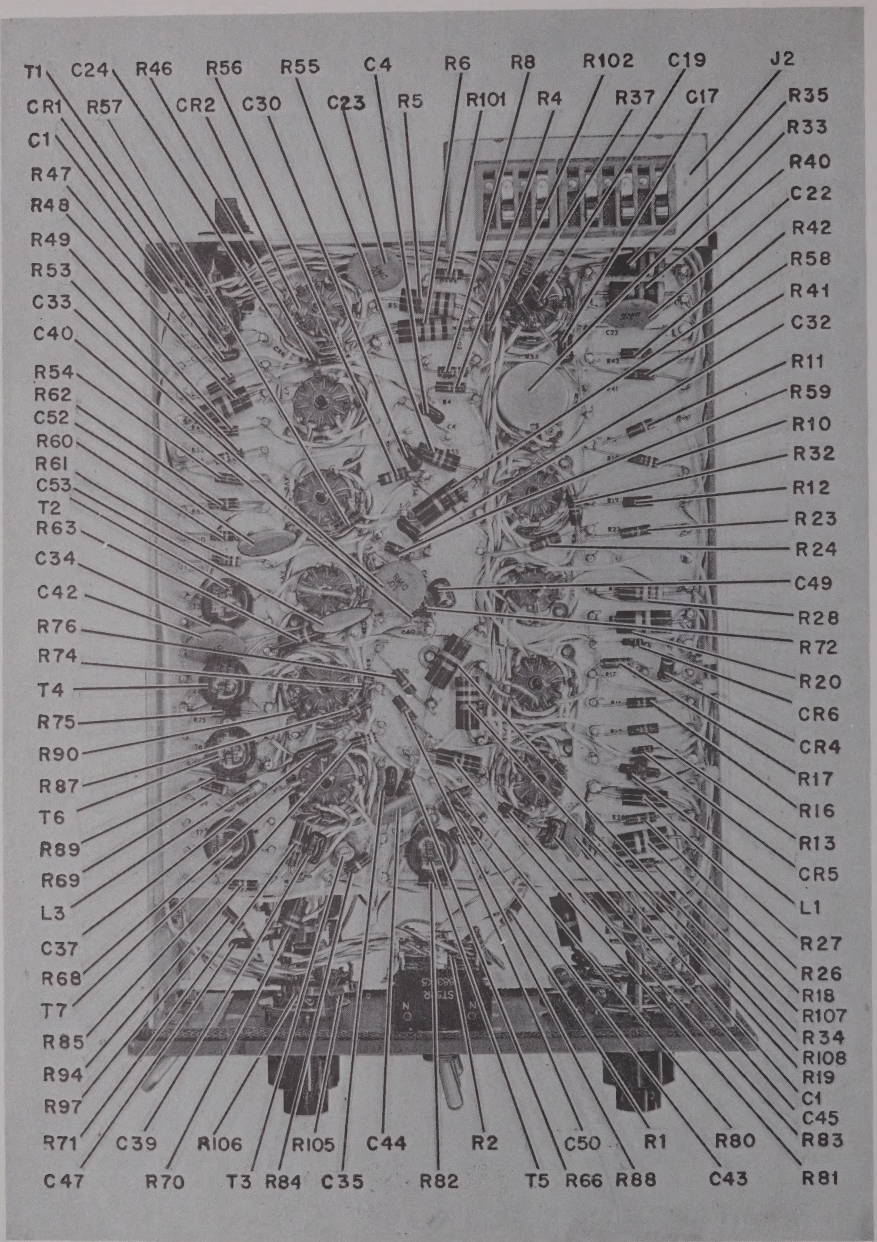
REF DESIG PREFIX 2

Figure 5-31. Sweep and Intensity Mark Unit, Right Side, Parts Location (Sheet 1 of 2)



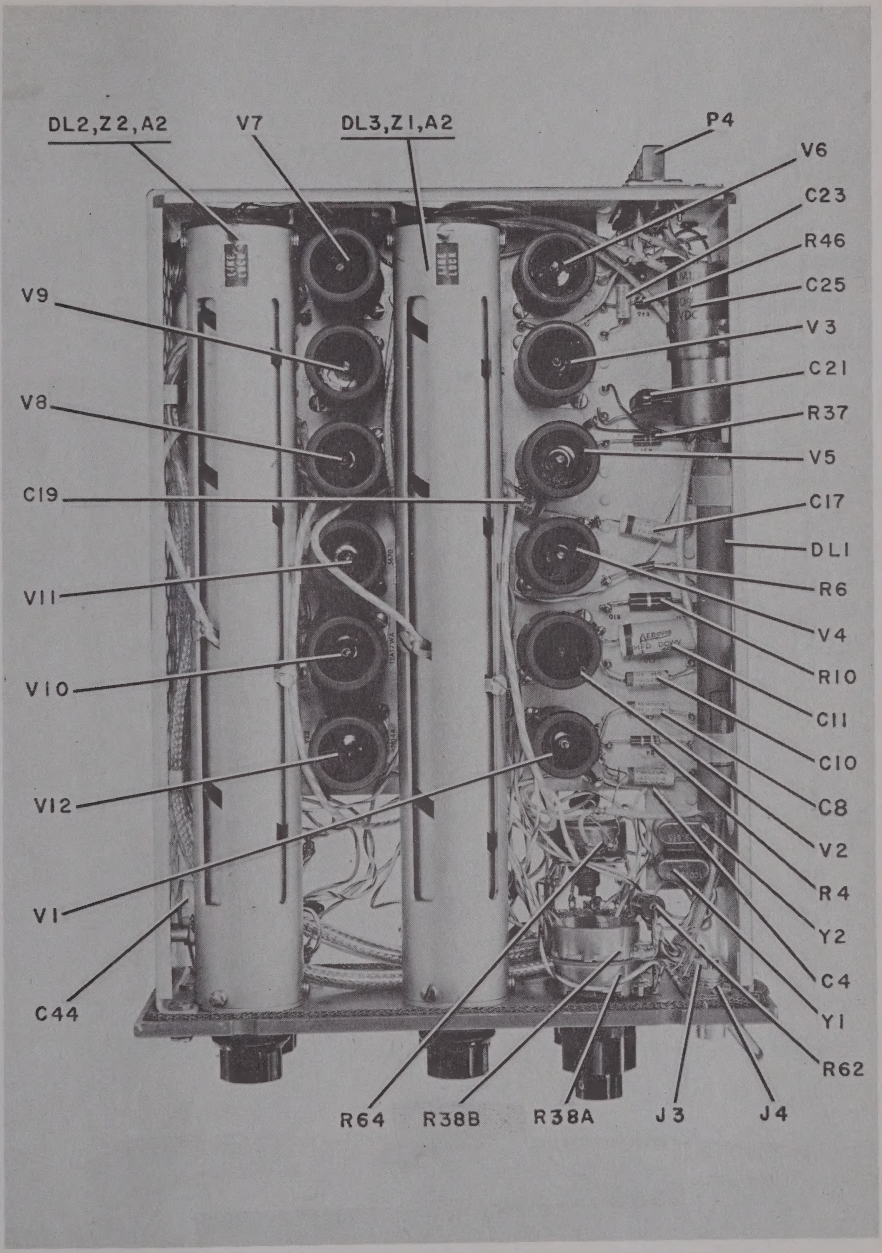
REF DESIG PREFIX 2

Figure 5-31. Sweep and Intensity Mark Unit, Right Side, Parts Location (Sheet 2 of 2)



REF DESIG PREFIX 2

Figure 5-32. Sweep and Intensity Mark Unit, Left Side, Parts Location



REF DESIG PREFIX 3

Figure 5-33. Crystal Mark and Sync Unit, Right Side, Parts Location (Sheet 1 of 2)

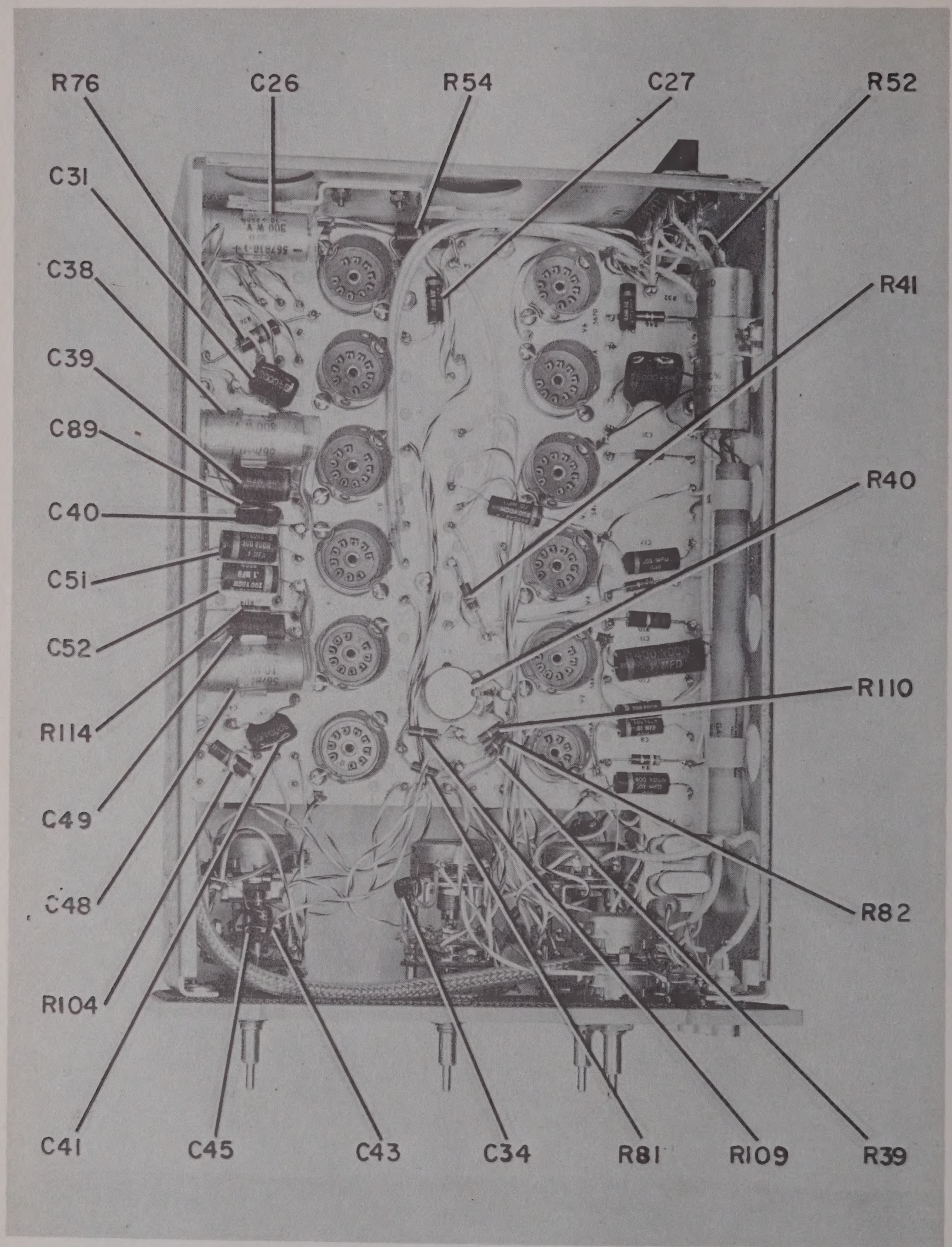


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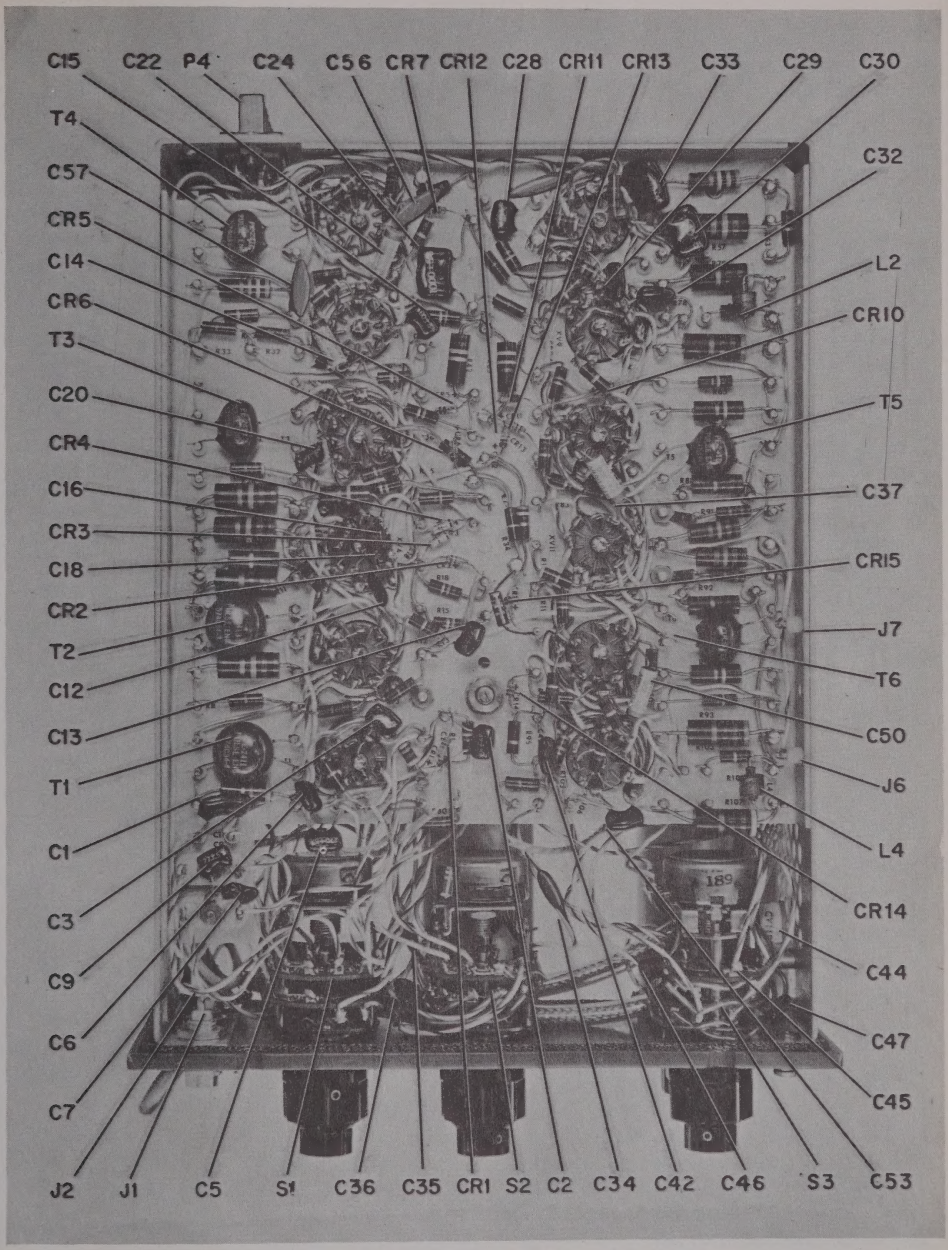
Figure 5-33. Crystal Mark and Sync Unit, Right Side, Parts Location (Sheet 2 of 2)



REF DESIG PREFIX 3

Figure 5-34. Crystal Mark and Sync Unit, Left Side, Parts Location (Sheet 1 of 2)

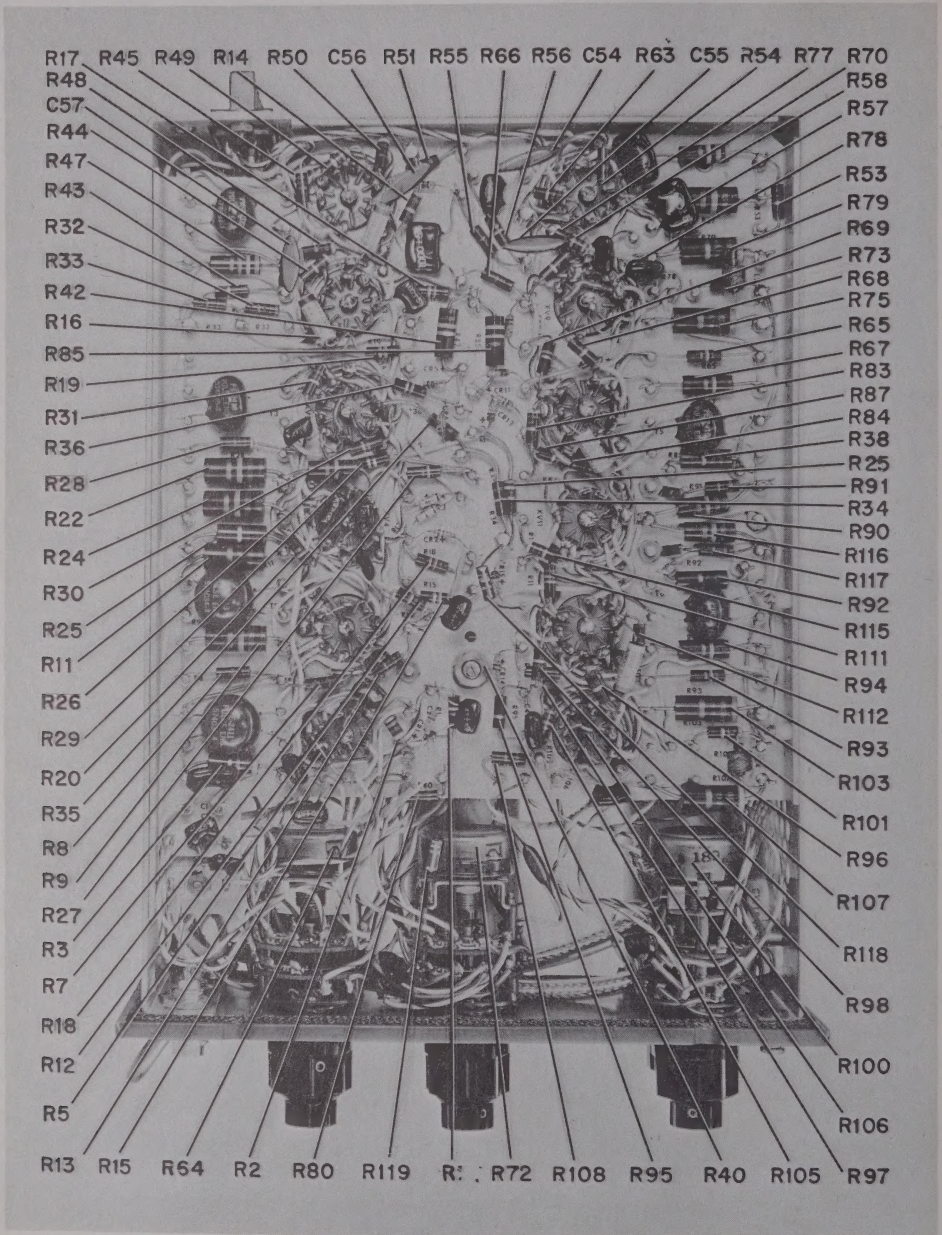


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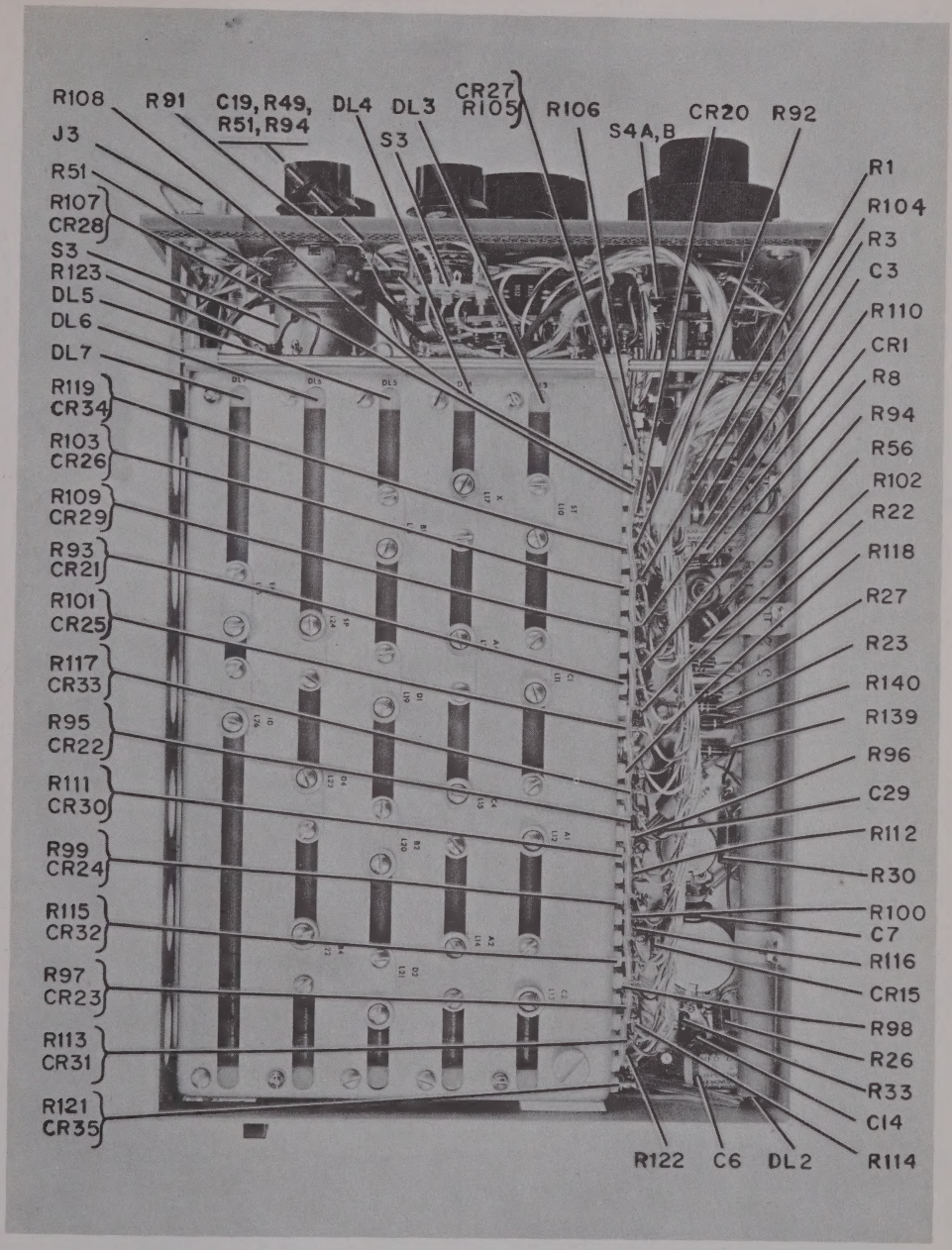
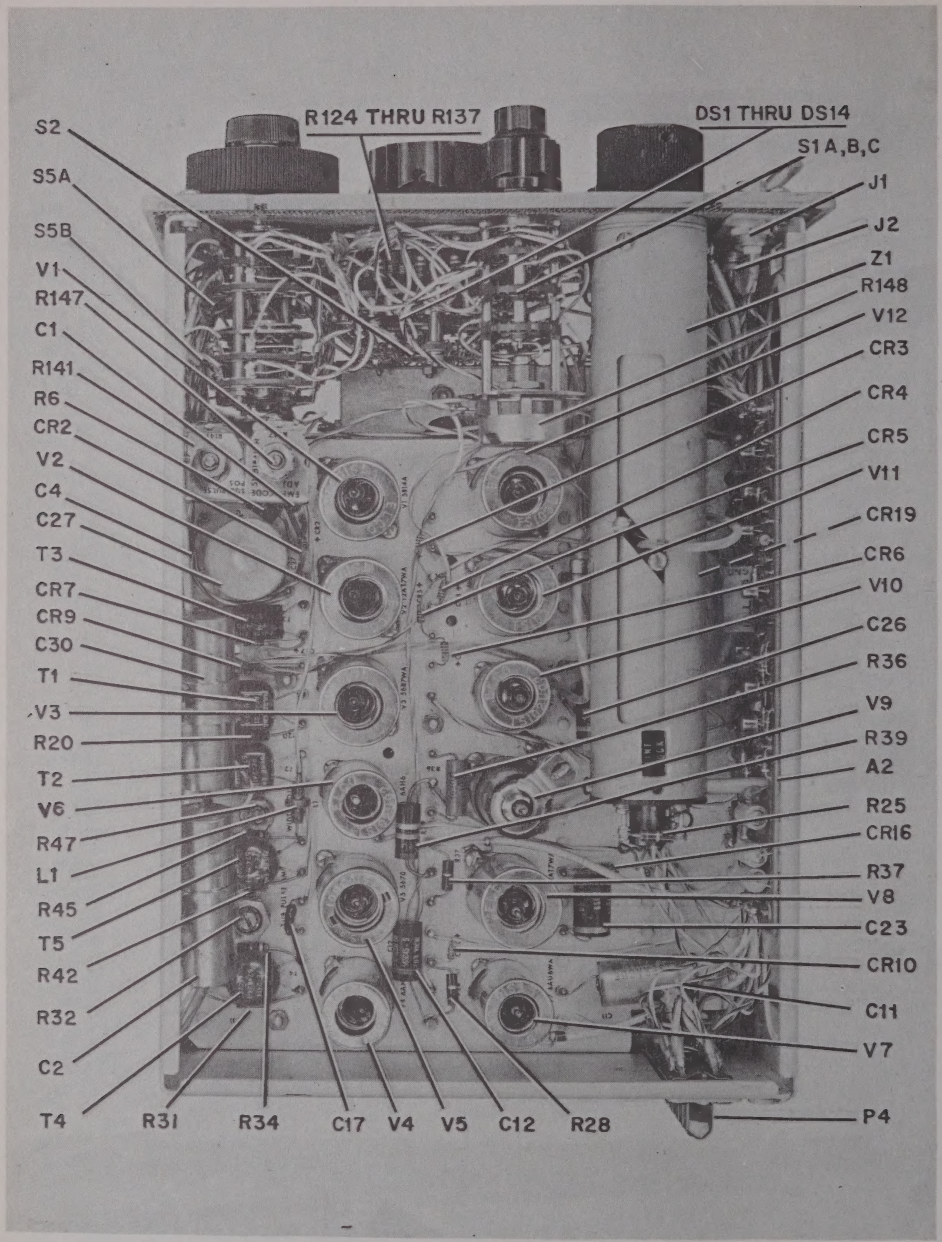
Figure 5-34. Crystal Mark and Sync Unit, Left Side, Parts Location (Sheet 2 of 2)



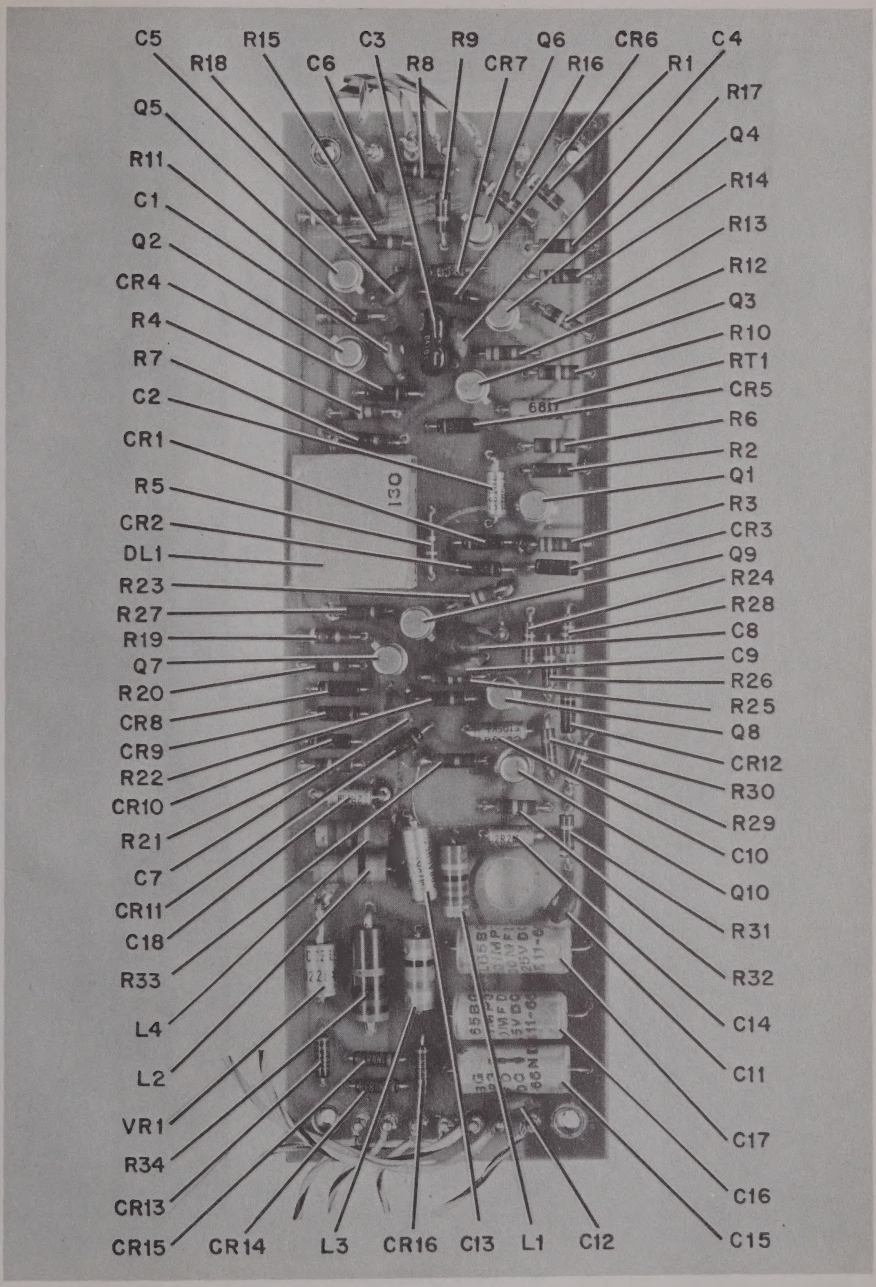
REF DESIG PREFIX 4

Figure 5-35. SIF Coder, Right Side, Parts Location



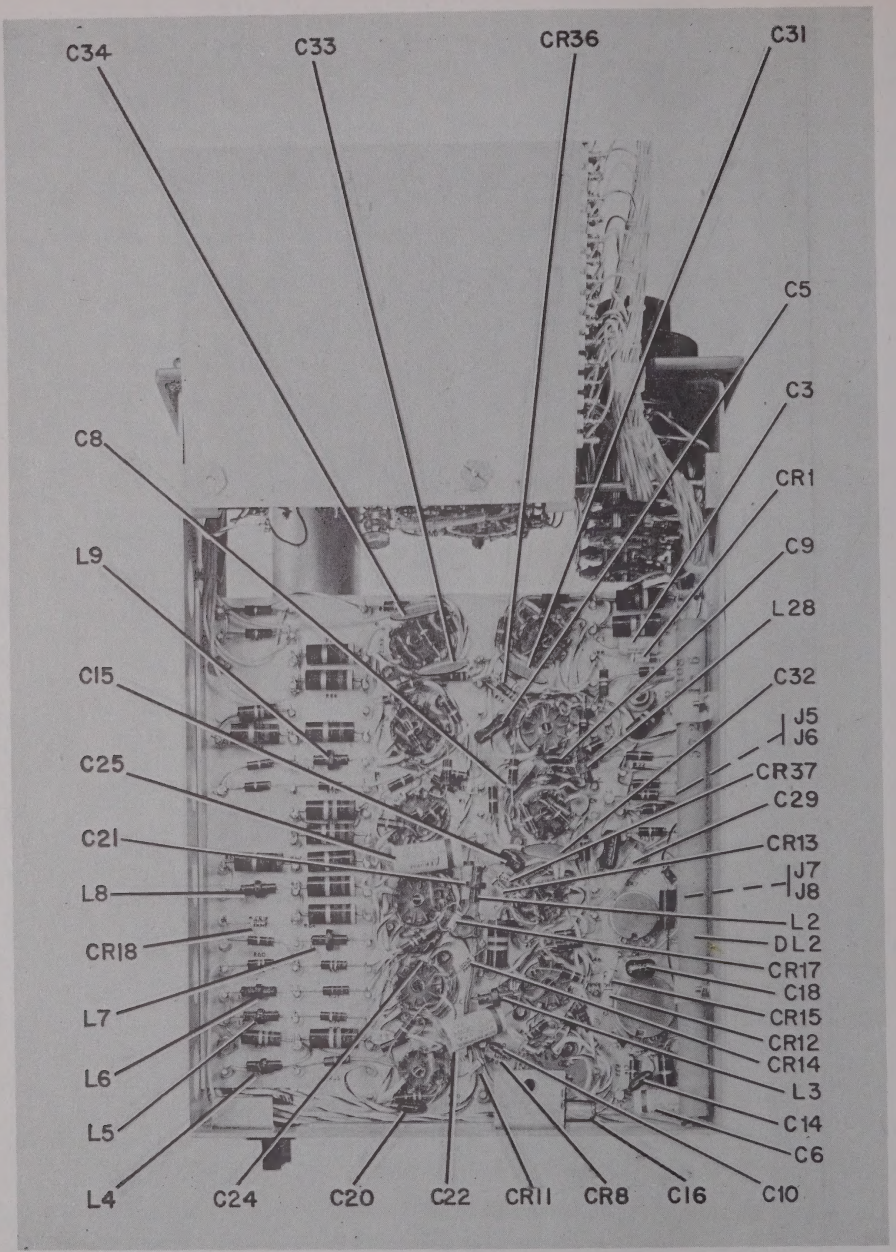
REF DESIG PREFIX 4

Figure 5-36. SIF Coder, Left Side, Parts Location



REF DESIG PREFIX 4A2

Figure 5-37. Interleave Assembly 4A2, Parts Location



REF DESIG PREFIX 4

Figure 5-38. SIF Coder, Delay Lines Raised, Parts Location (Sheet 1 of 2)

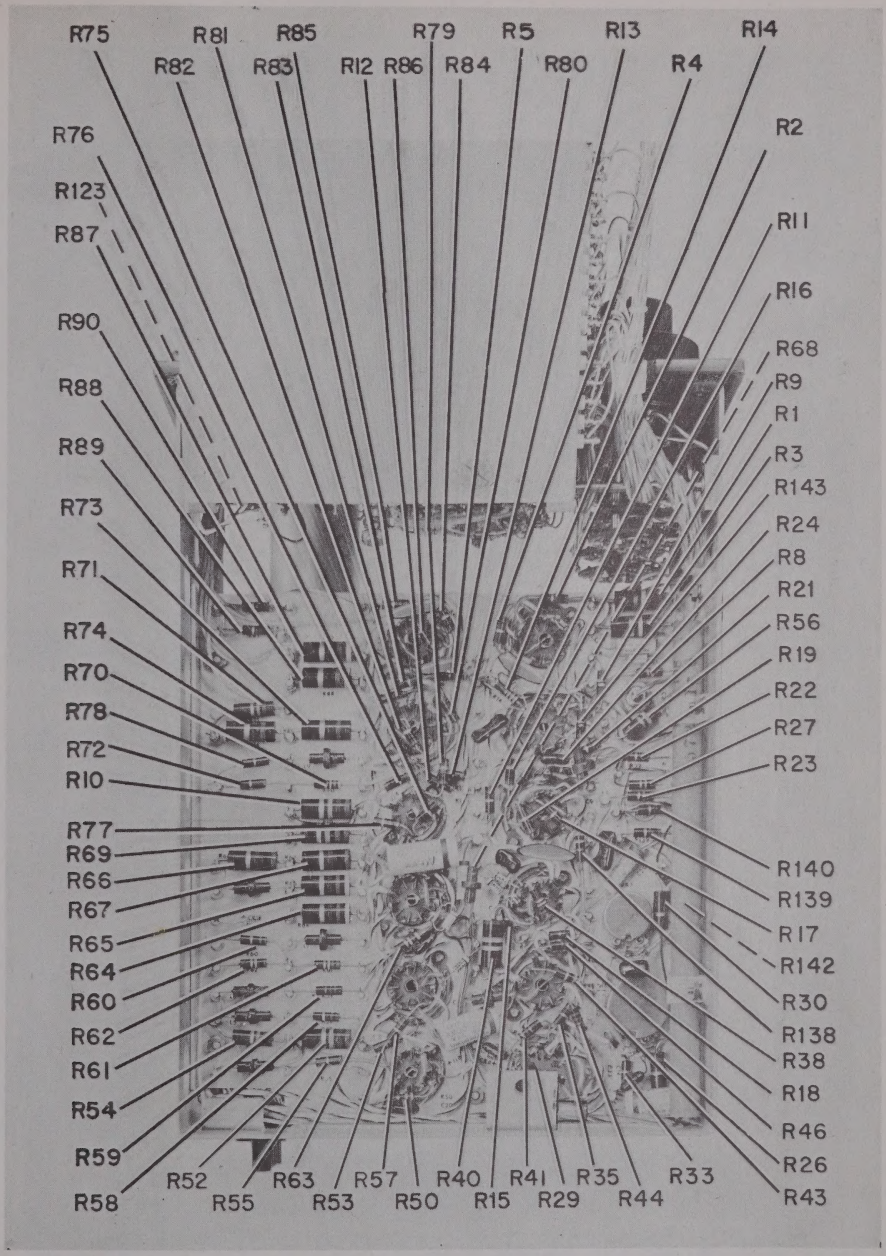


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Figure 5-38. SIF Coder, Delay Lines Raised, Parts Location (Sheet 2 of 2)

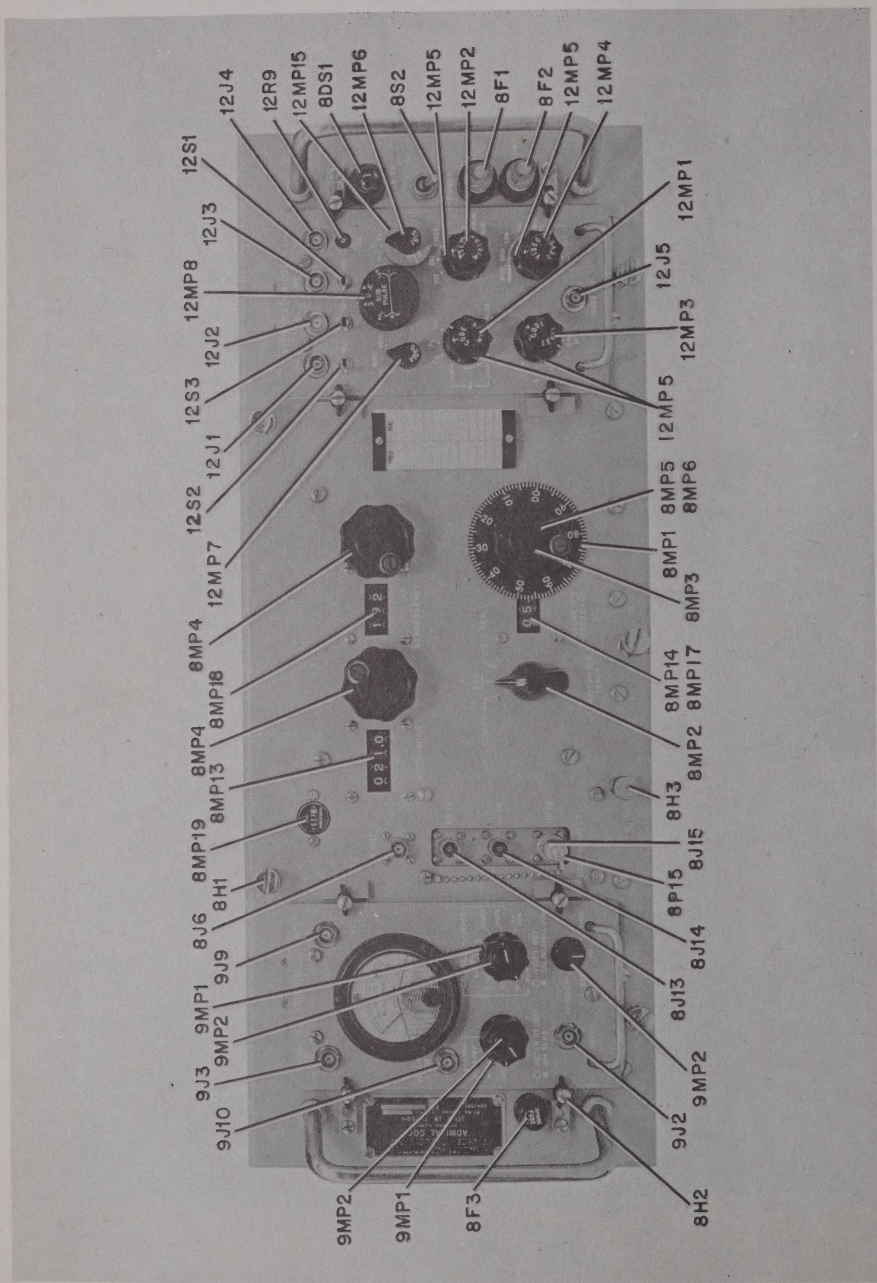
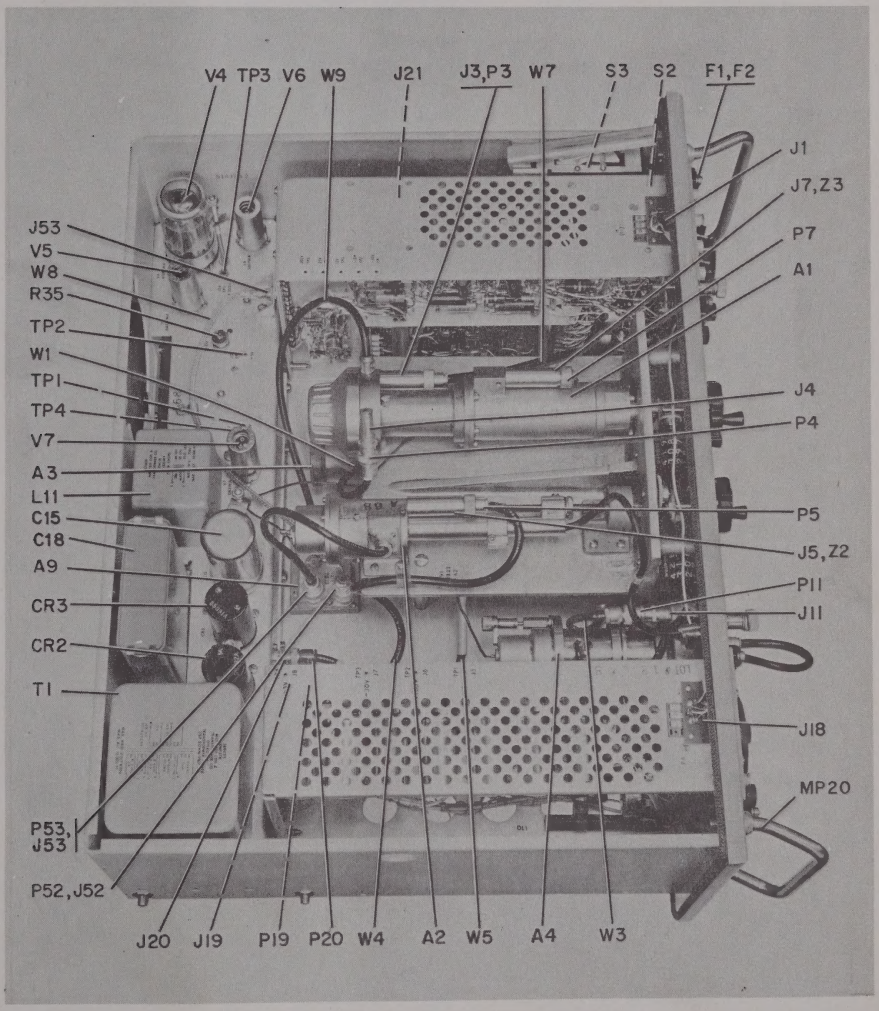
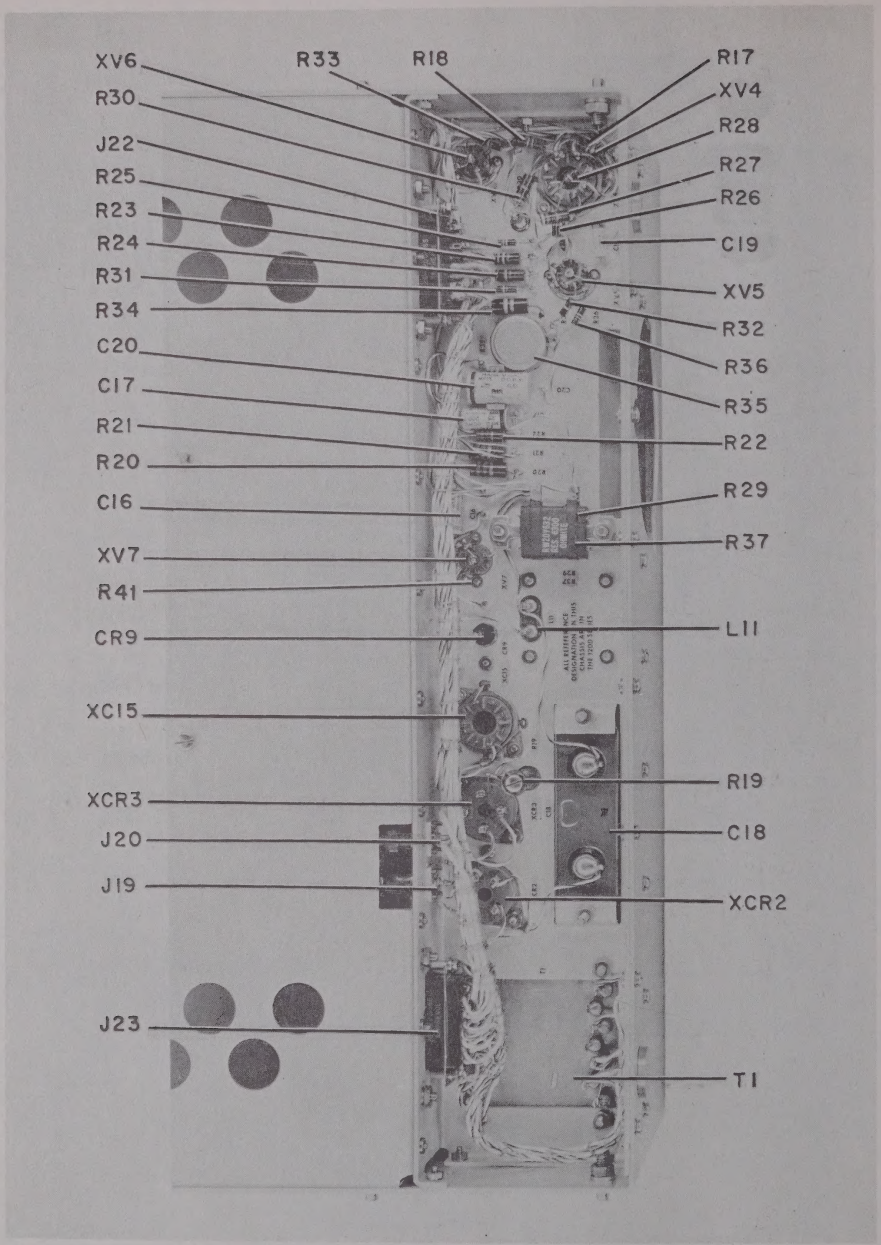


Figure 5-39. Coder Simulator SM-197A/UPM-98, Front Panel, Parts Location



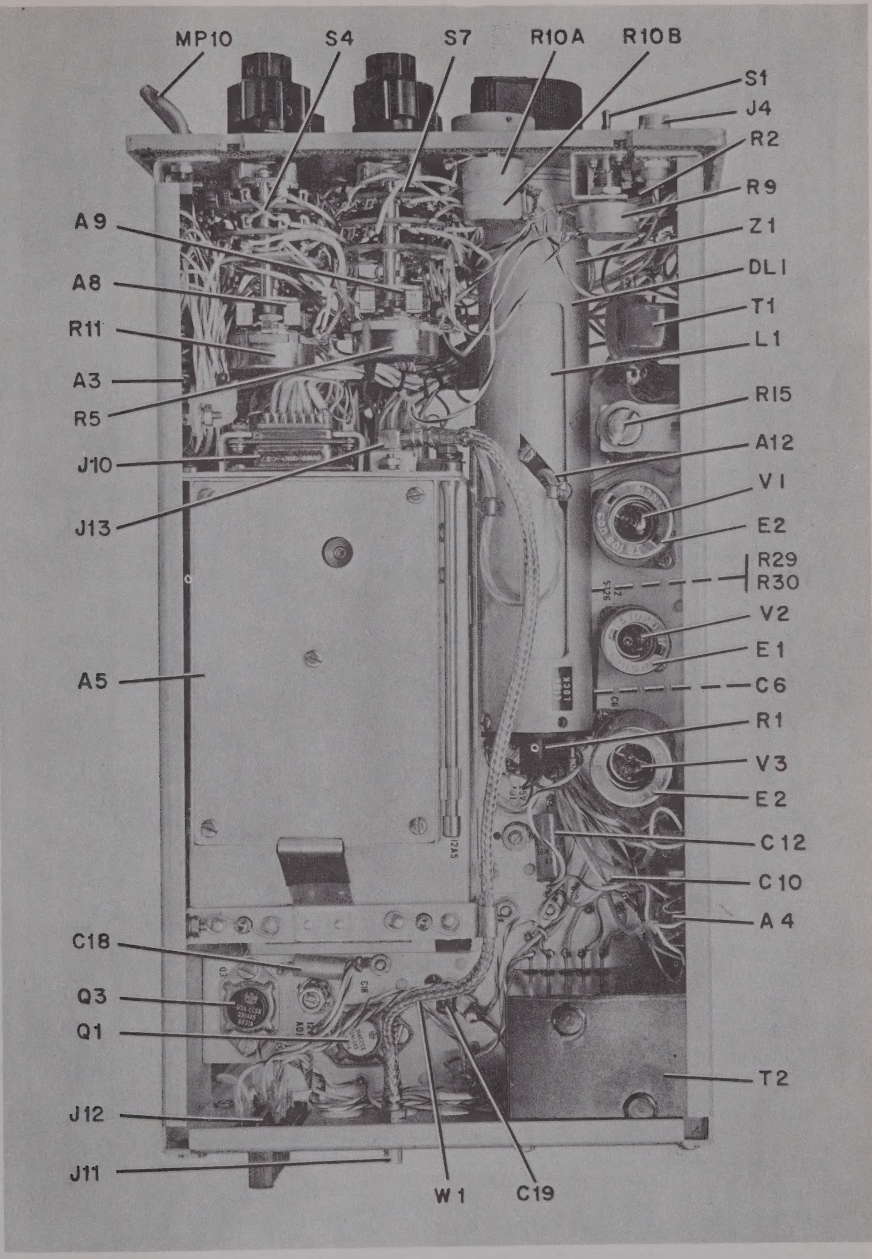
REF DESIG PREFIX 8

Figure 5-40. Coder Simulator SM-197A/UPM-98, Panel Chassis, Top, Parts Location



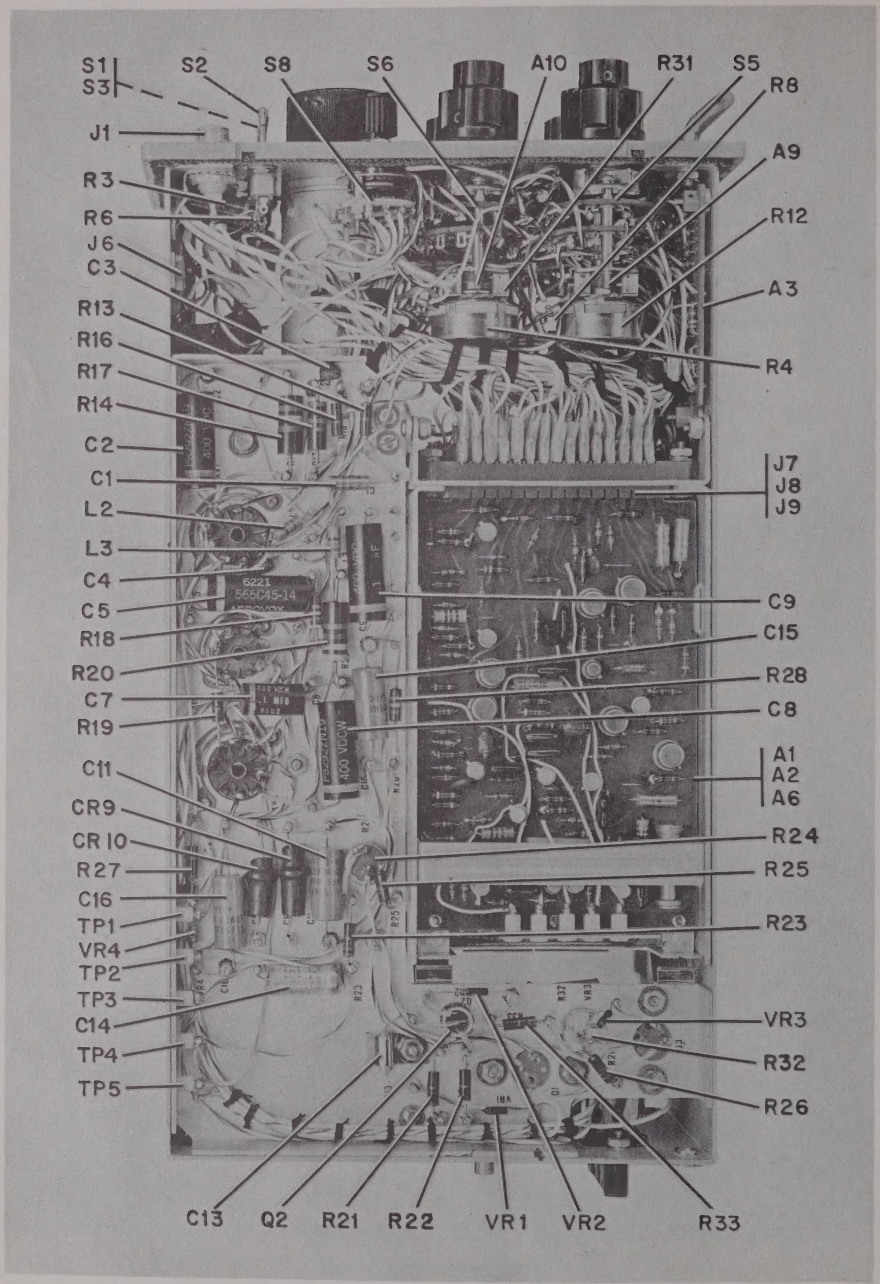
REF DESIG PREFIX 8

Figure 5-41. Coder Simulator SM-197A, Panel Chassis, Bottom, Parts Location



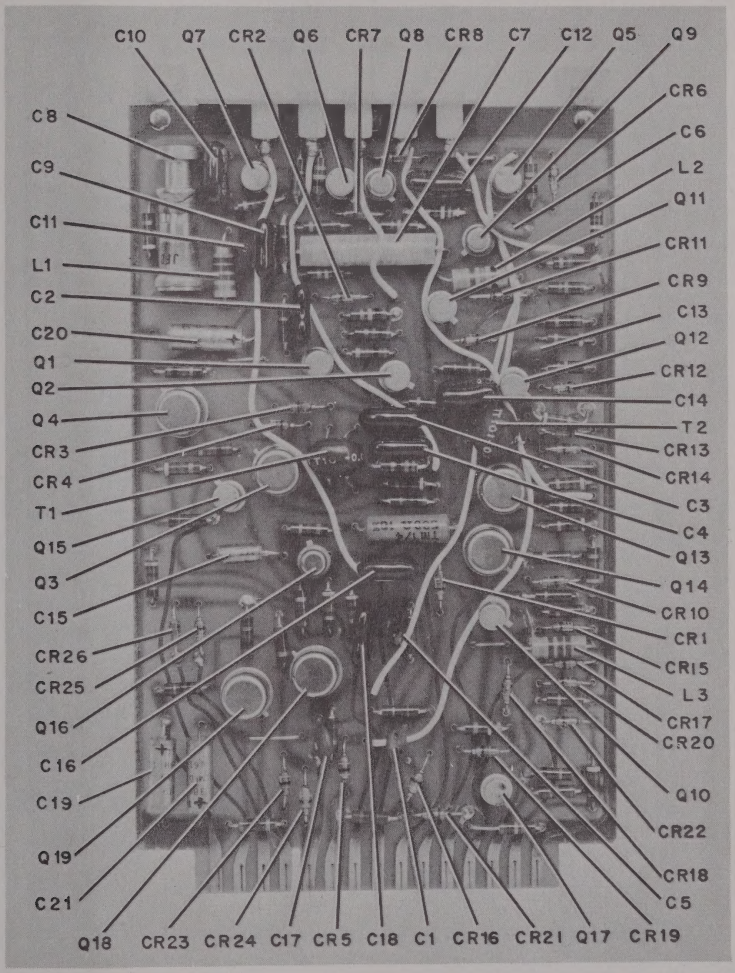
REF DESIG PREFIX 12

Figure 5-42. Interrogation Coder, Right Side, Parts Location



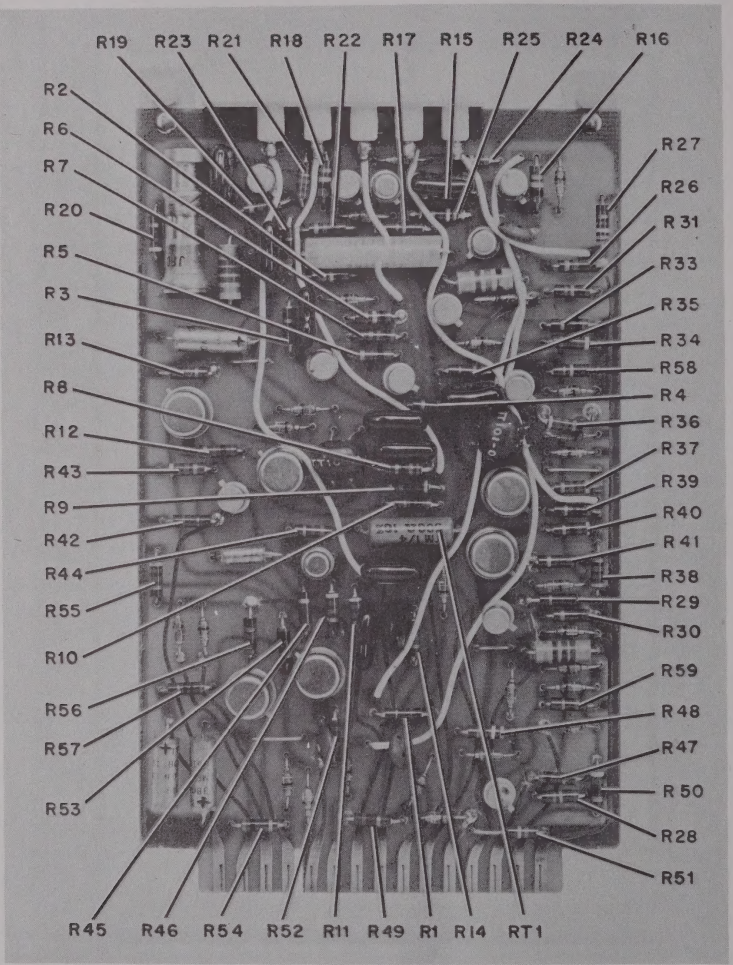
REF DESIG PREFIX 12

Figure 5-43. Interrogation Coder, Left Side, Parts Location



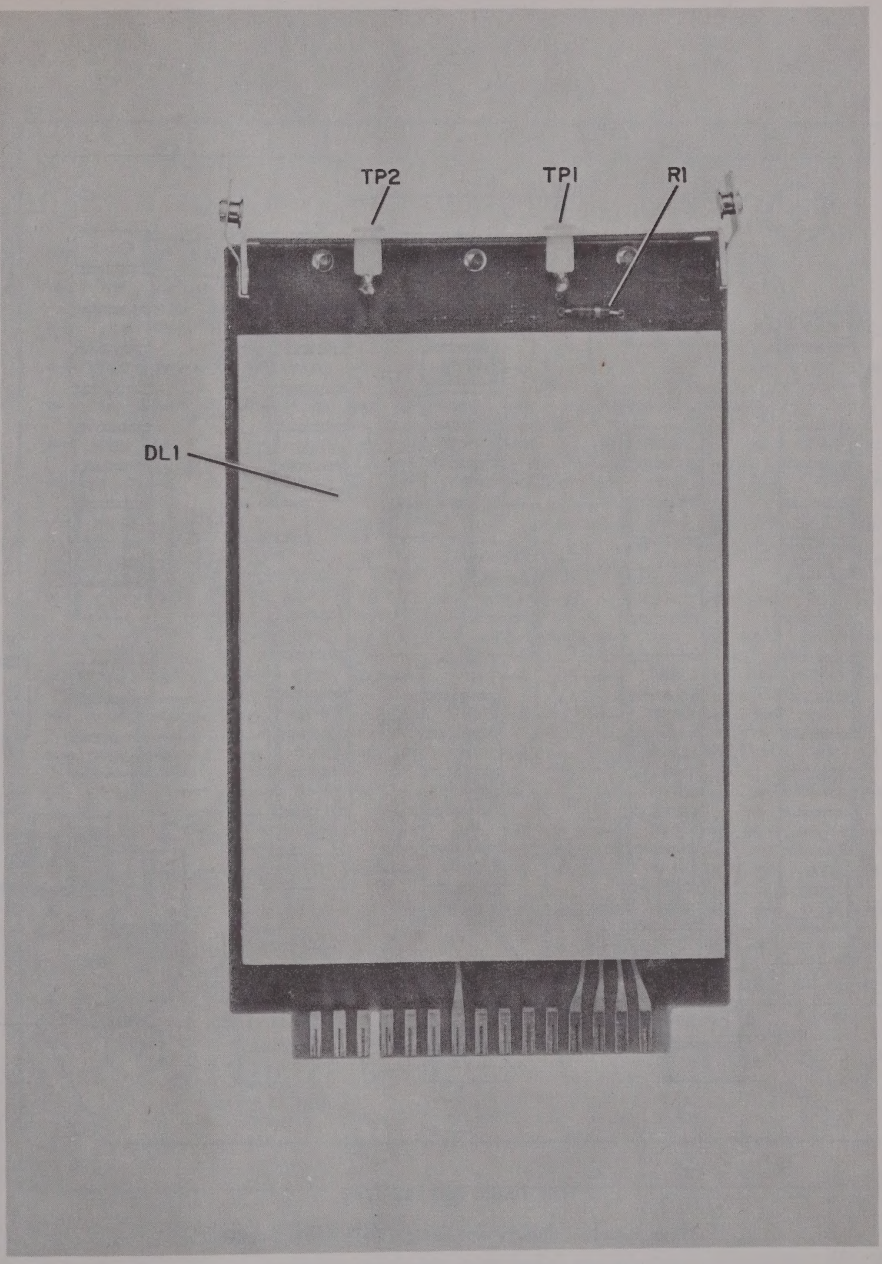
REF DESIG PREFIX 12A1

Figure 5-44. Clock and Line Drive Assembly 12A1, Parts Location (Sheet 1 of 2)



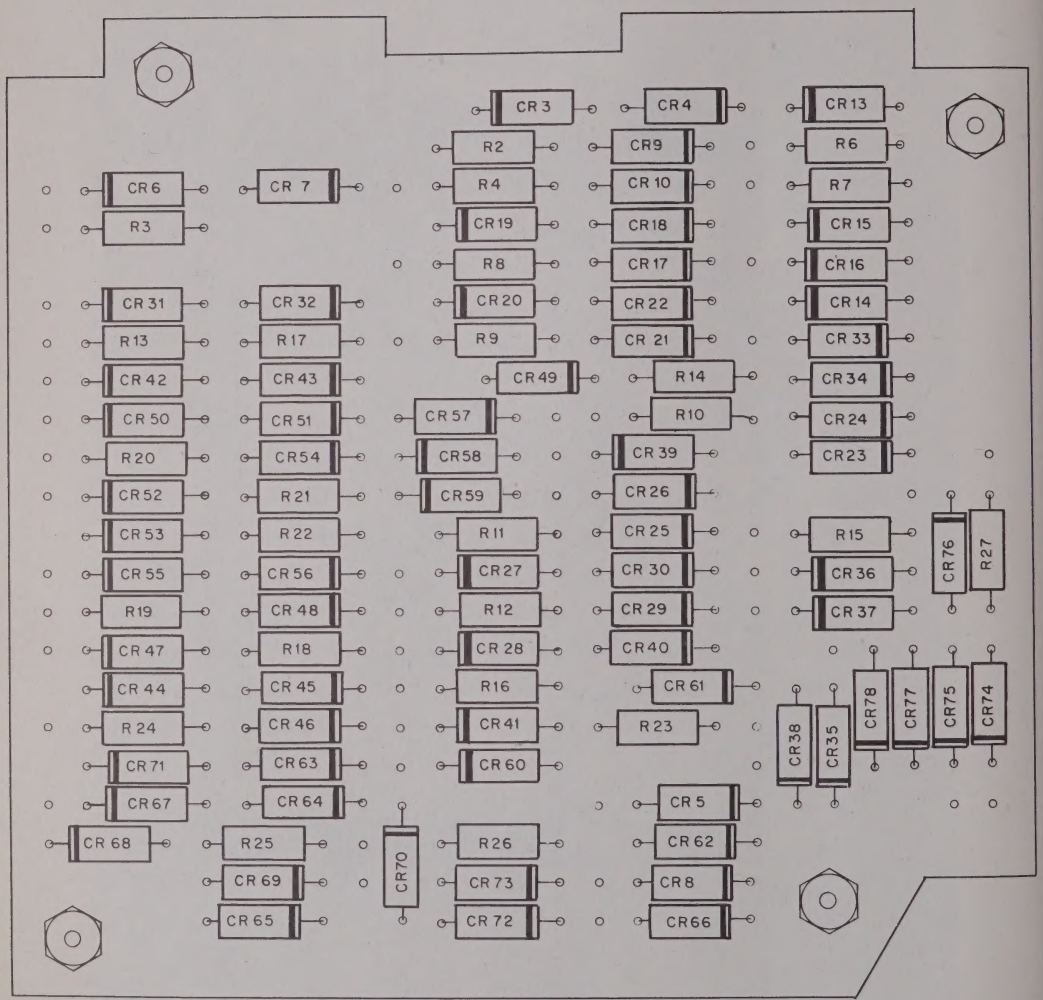
REF DESIG PREFIX 12A1

Figure 5-44. Clock and Line Drive Assembly 12A1, Parts Location (Sheet 2 of 2)



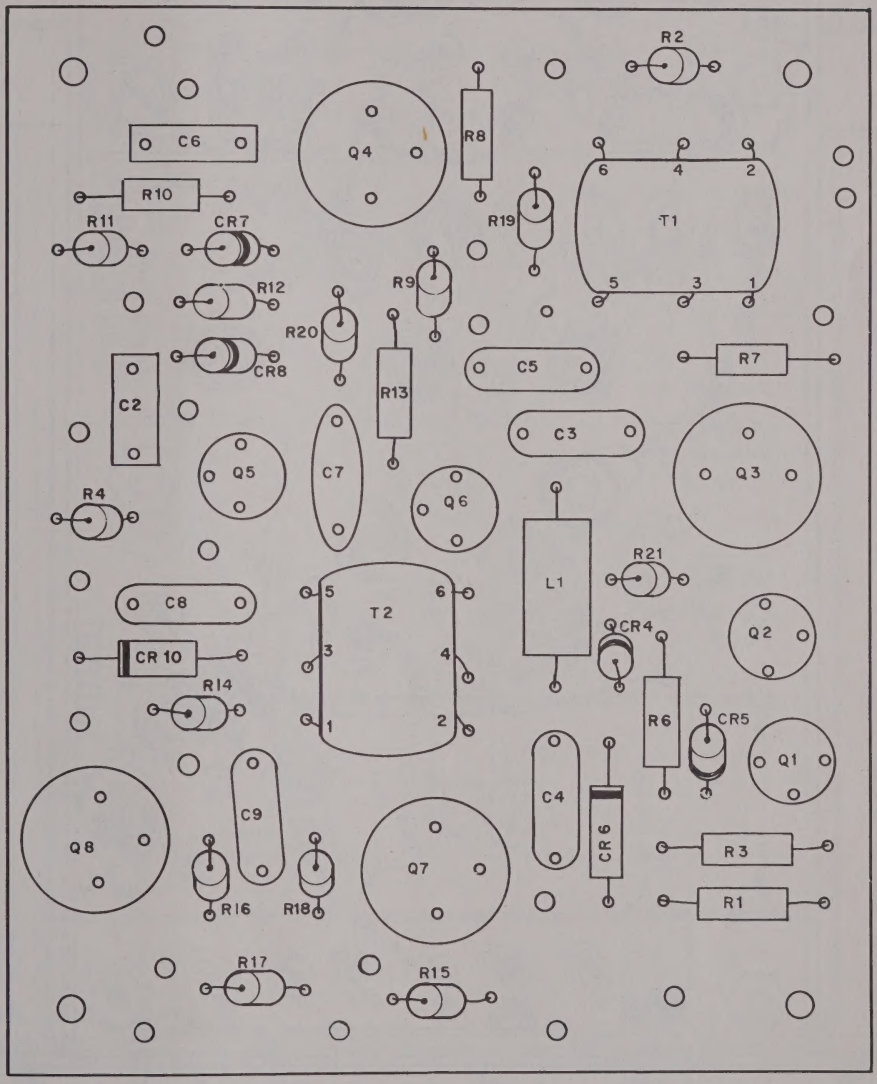
REF DESIG PREFIX 12A2

Figure 5-45. Delay Line Assembly 12A2, Parts Location



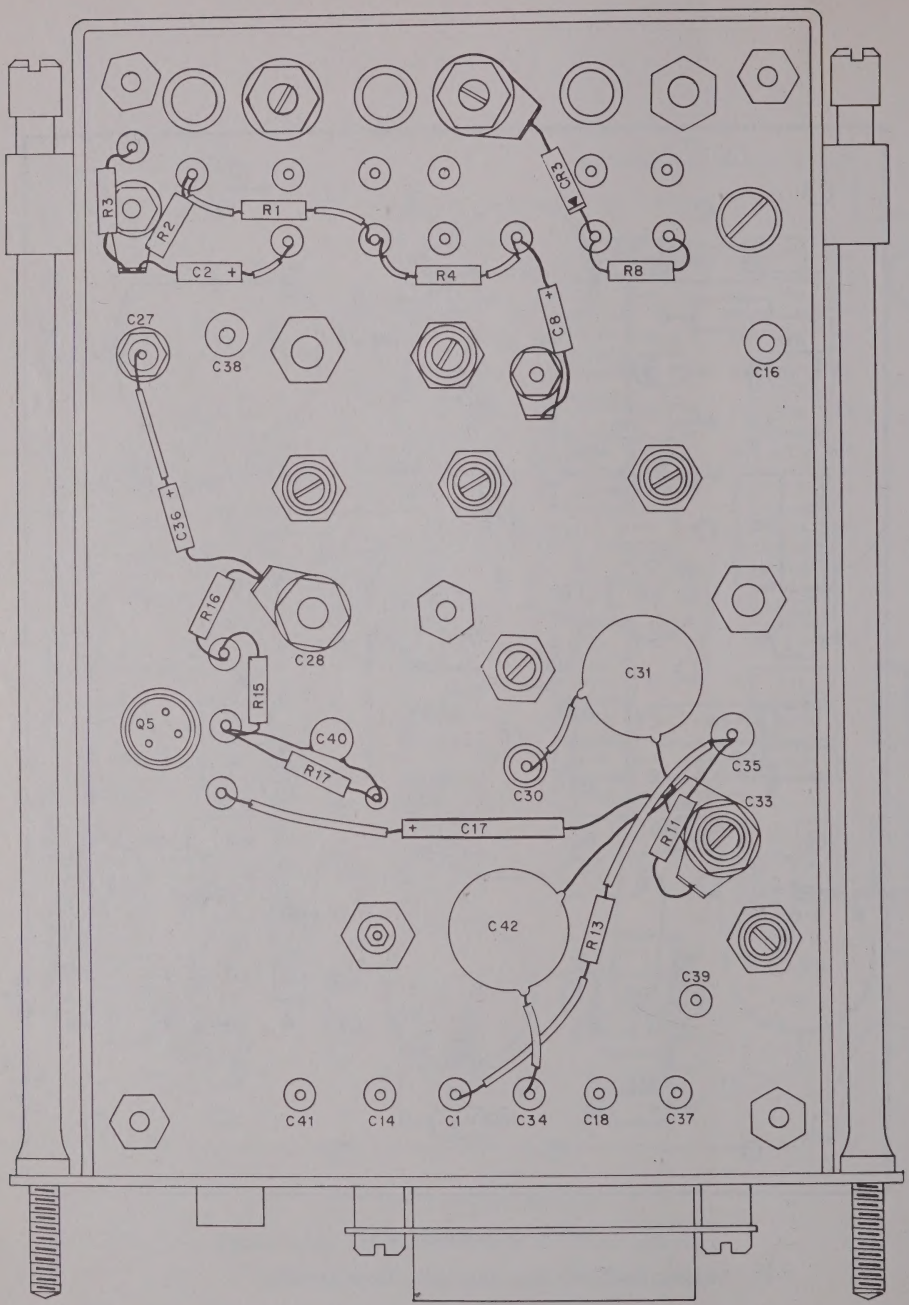
REF DESIG PREFIX 12A3

Figure 5-46. Matrix Assembly 12A3, Parts Location



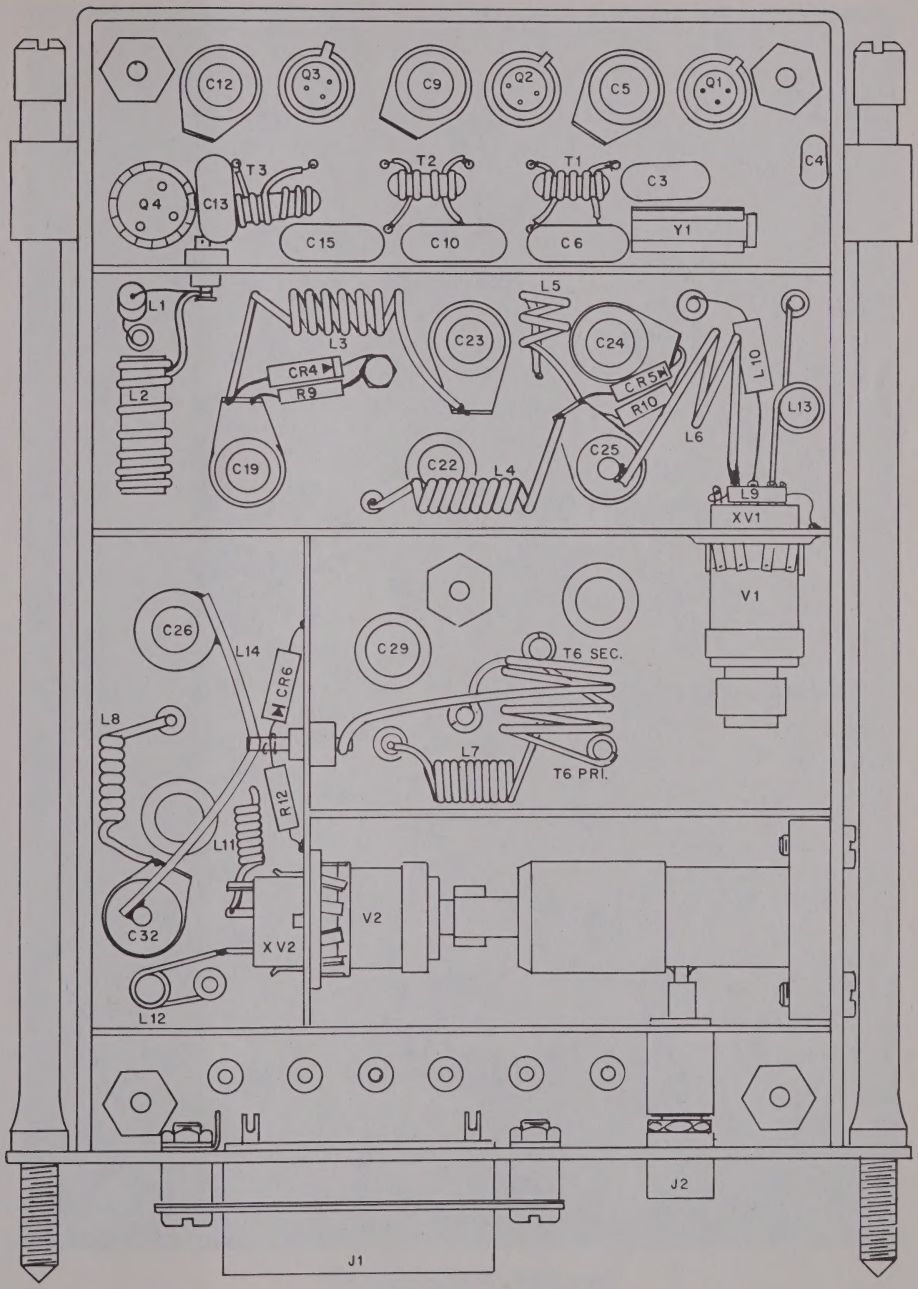
REF DESIG PREFIX 12A4

5-47. Blocking Oscillator Assembly 12A4, Parts Location



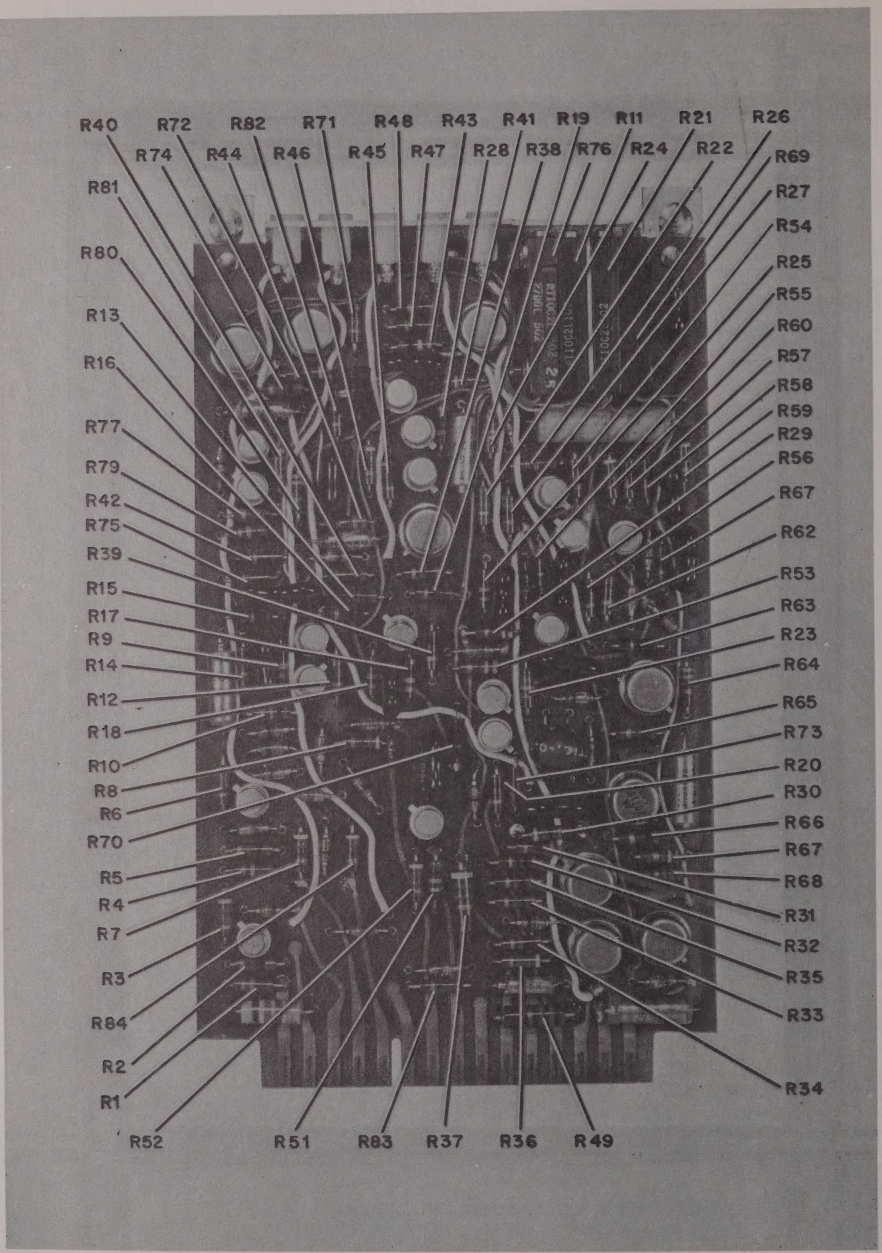
REF DESIG PREFIX 12A5

Figure 5-48. RF Subassembly 12A5, Right Side, Parts Location



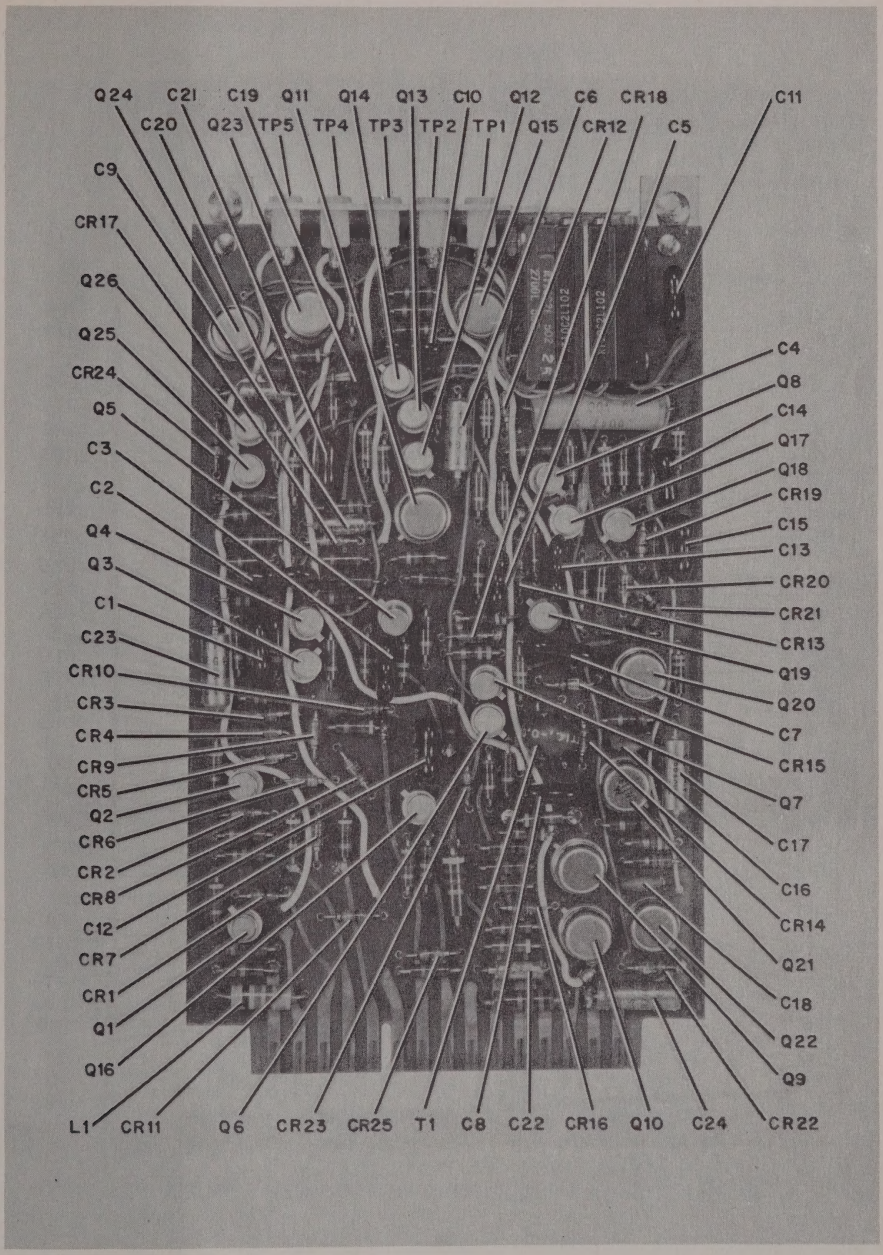
REF DESIG PREFIX 12A5

Figure 5-49. RF Subassembly 12A5, Left Side, Parts Location



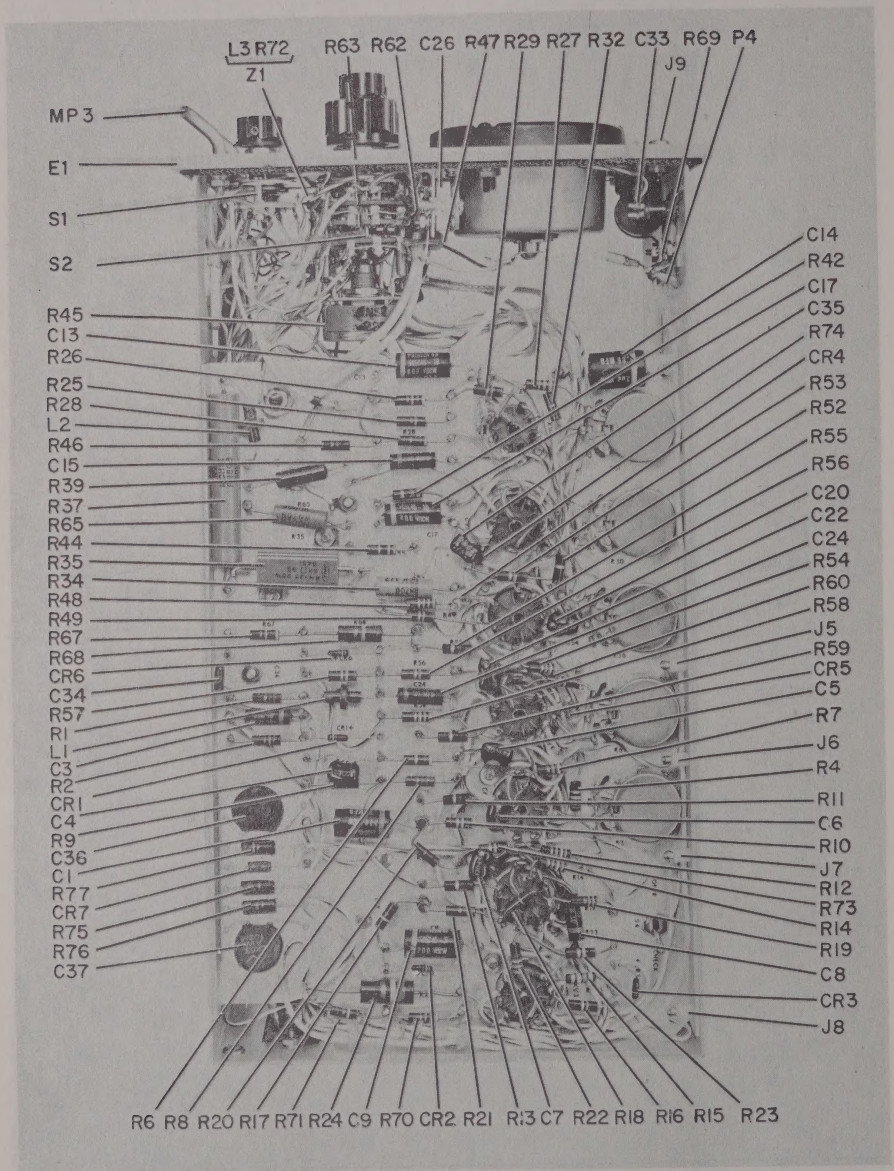
REF DESIG PREFIX 12A6

Figure 5-50. Delay and Tag Generator Assembly 12A6, Parts Location (Sheet 1 of 2)



REF DESIG PREFIX 12A6

Figure 5-50. Delay and Tag Generator Assembly 12A6, Parts Location (Sheet 2 of 2)



REF DESIG PREFIX 9

Figure 5-51. Calibration-Control Unit, Right Side, Parts Location

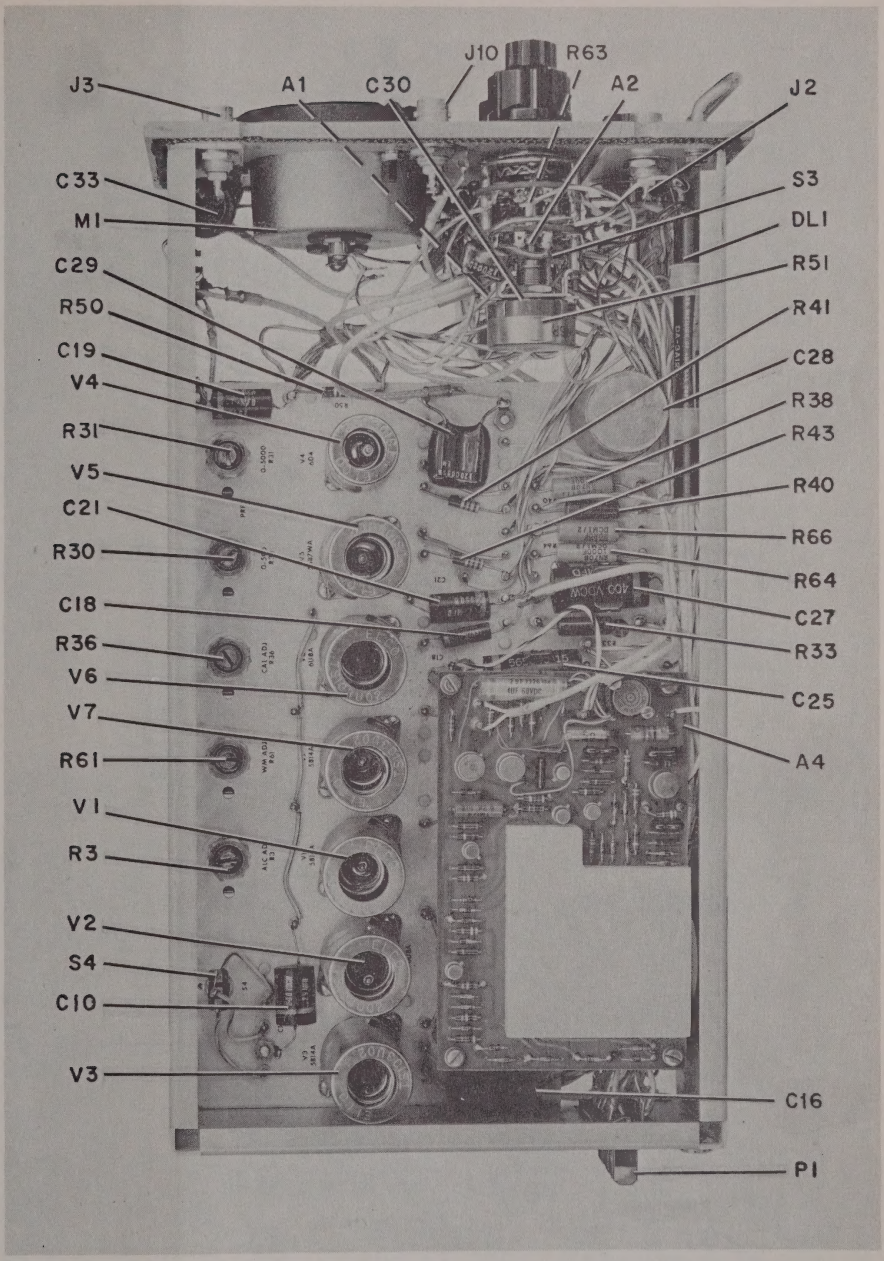


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Figure 5-52. Calibration-Control Unit, Left Side, Parts Location

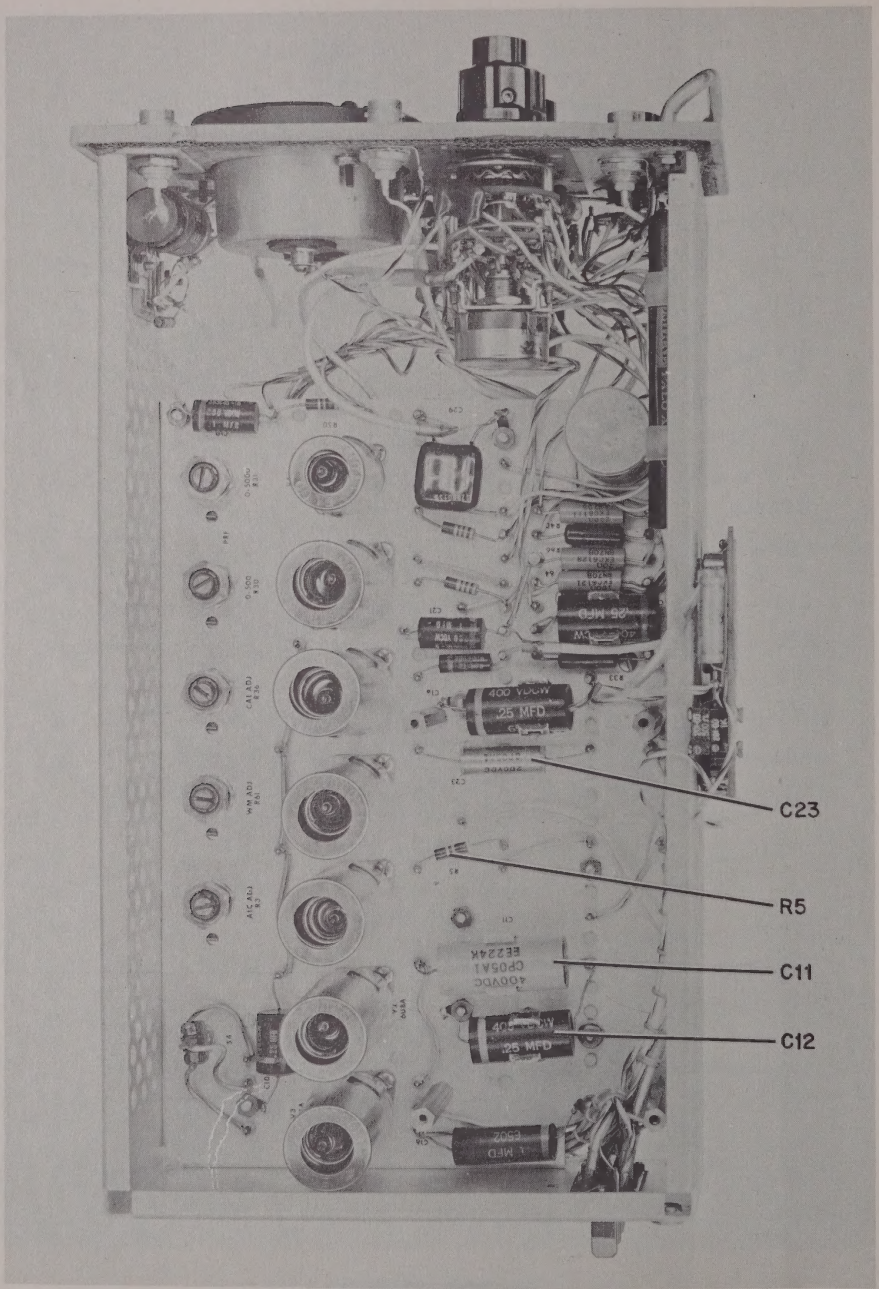

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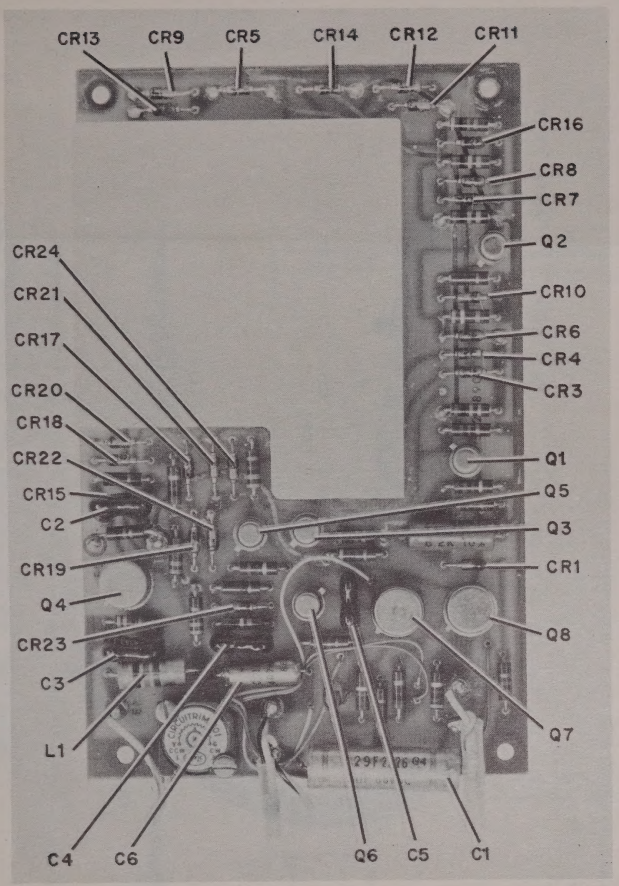
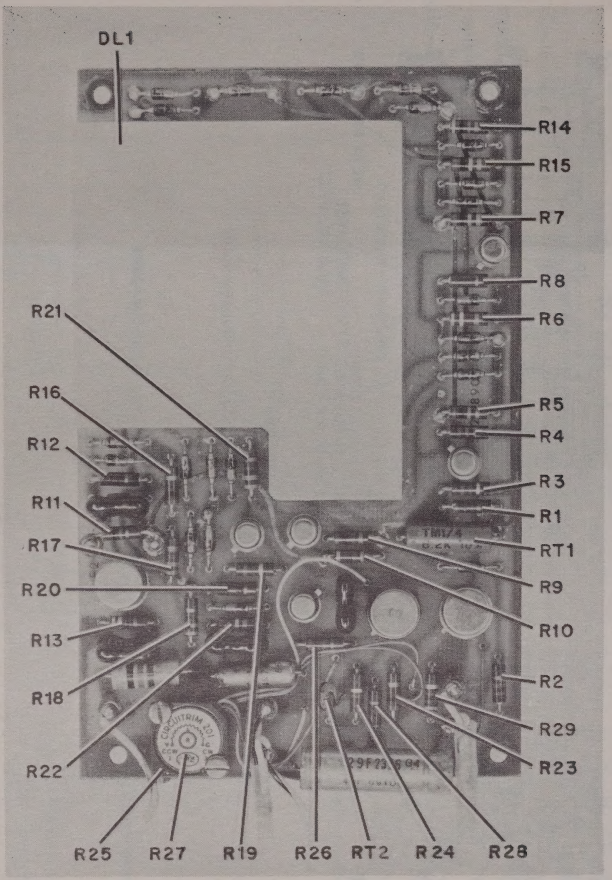
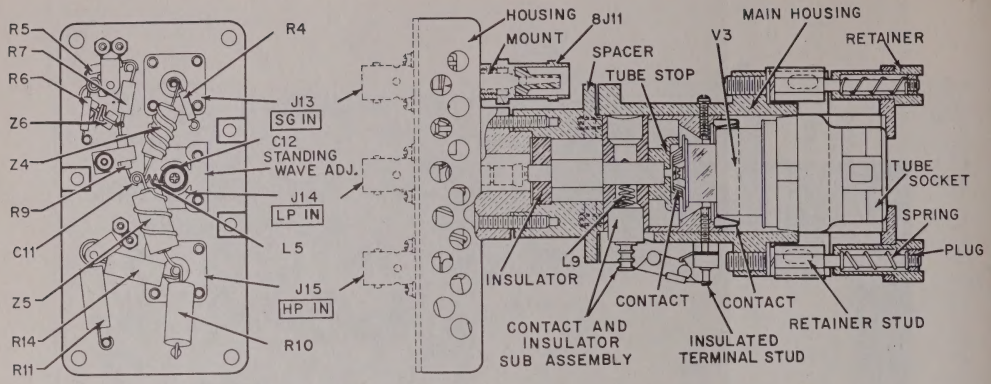
Figure 5-53. Calibration-Control Unit, Subassembly 9A4 Removed, Parts Location





REF DESIG PREFIX 9A4

Figure 5-54. Reply Decoder Subassembly 9A4, Parts Location



REF DESIG PREFIX 8

Figure 5-55. Sectional View of Demodulator Subassembly

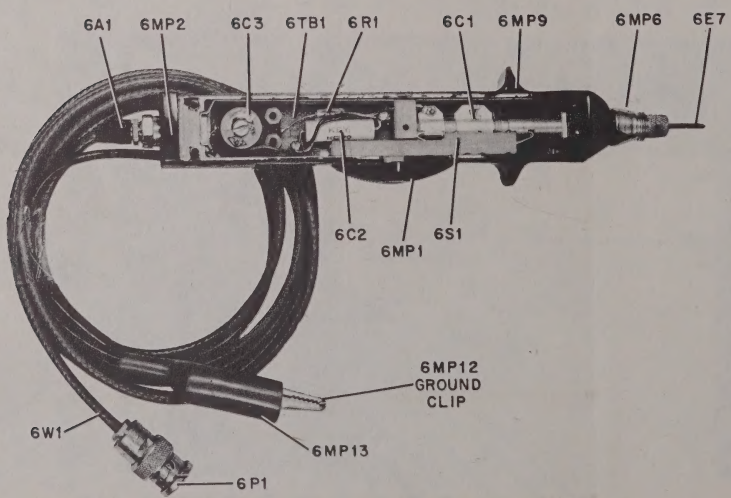
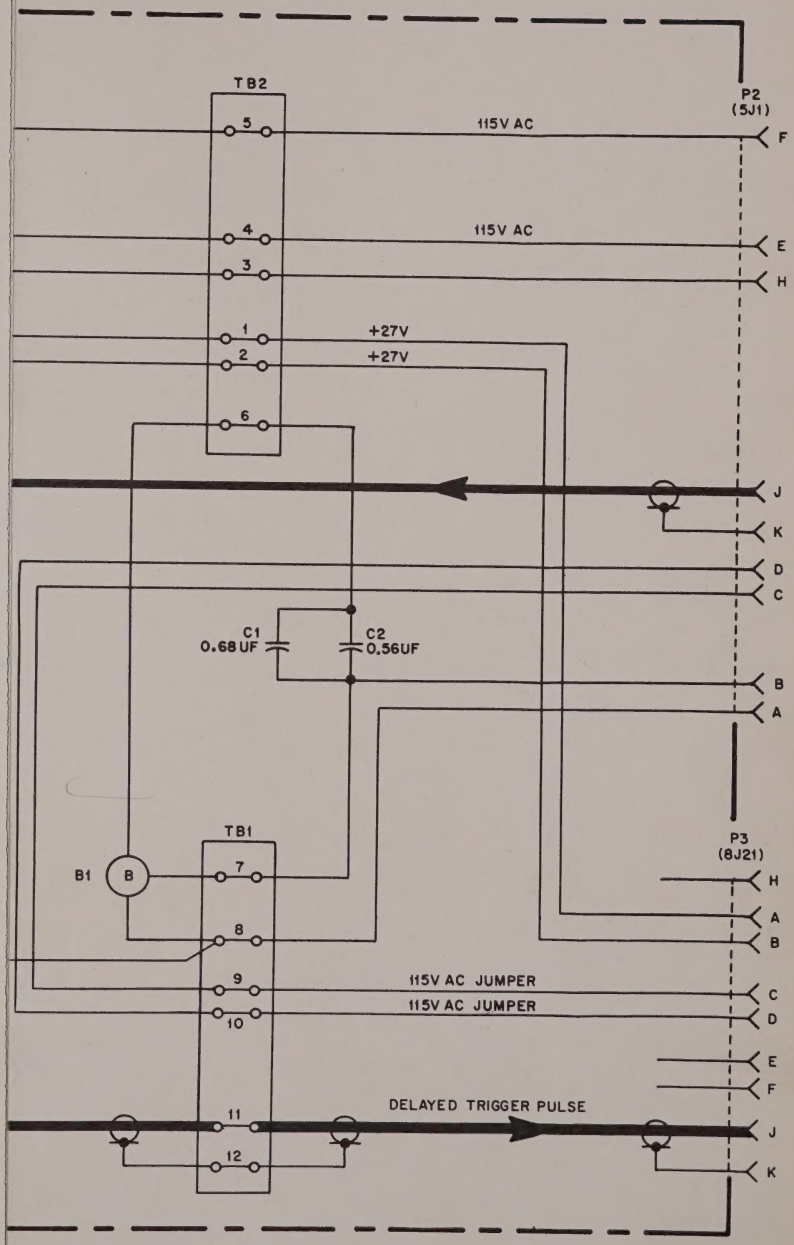
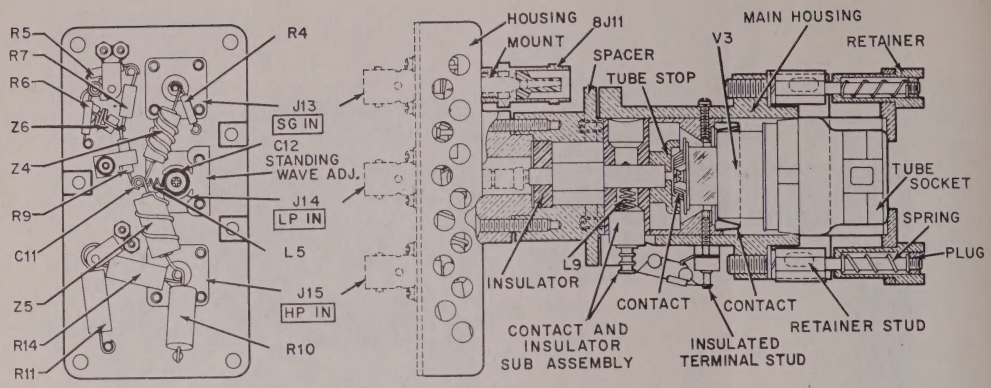


Figure 5-56. Test Lead MX-2681/UP, Internal Parts Location



igure 5-57. Electrical Equipment Case CY-2726A/UPM-98, Schematic Diagram



REF DESIG PREFIX 8

Figure 5-55. Sectional View of Demodulator Subassembly

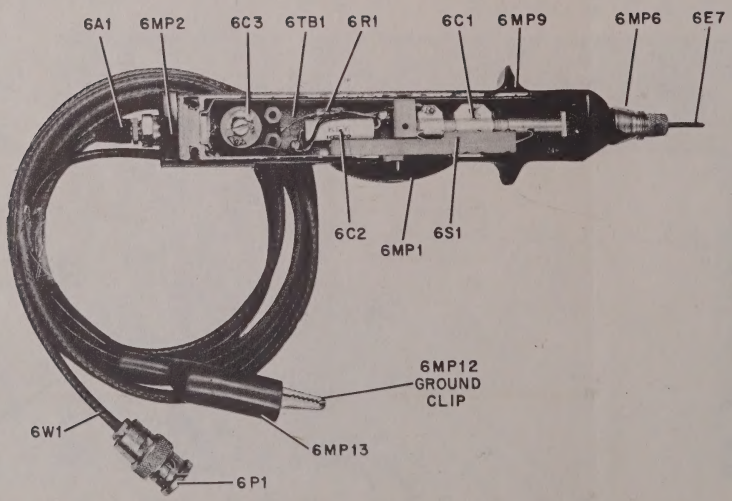


Figure 5-56. Test Lead MX-2681/UP, Internal Parts Location

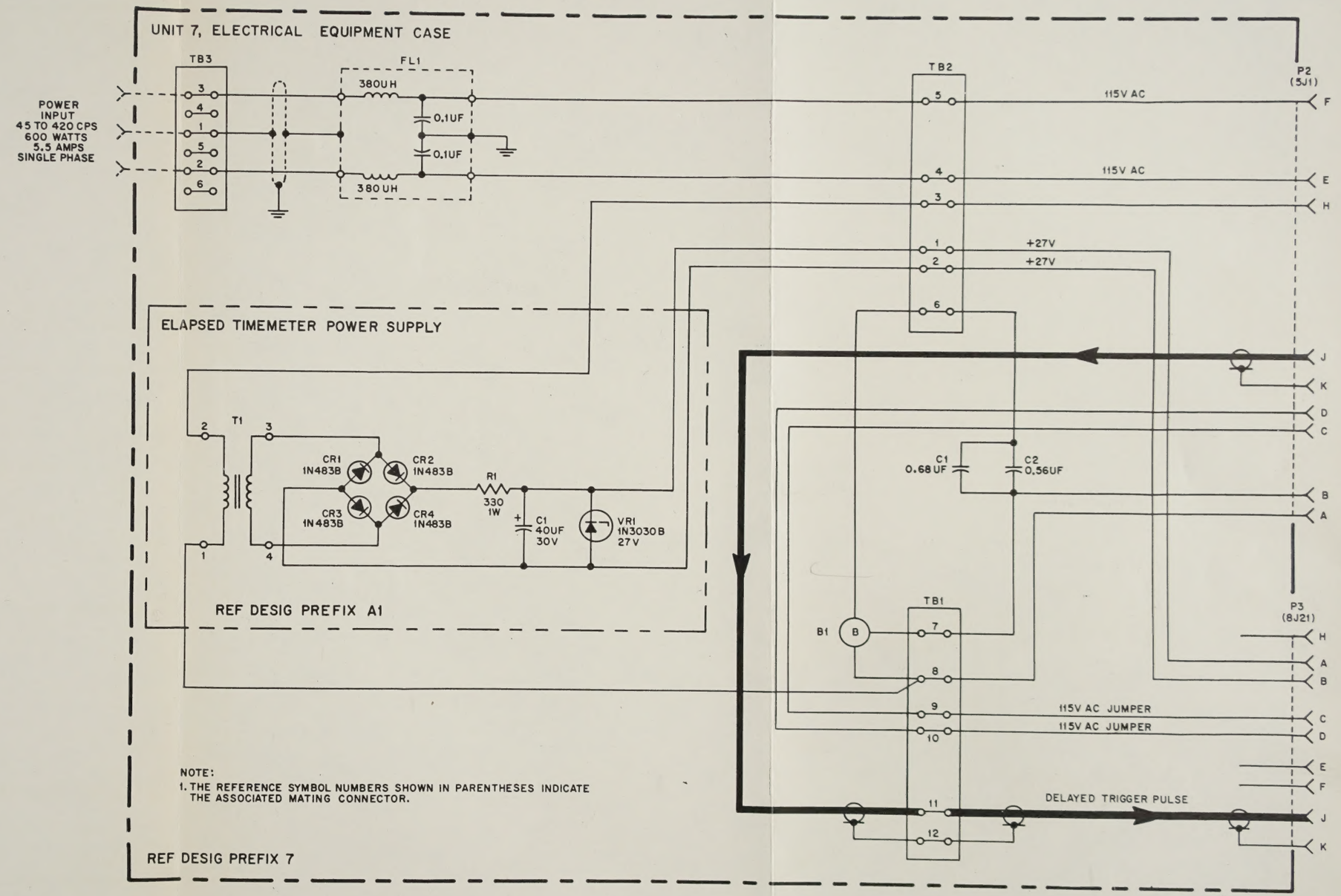


Figure 5-57. Electrical Equipment Case CY-2726A/UPM-98, Schematic Diagram

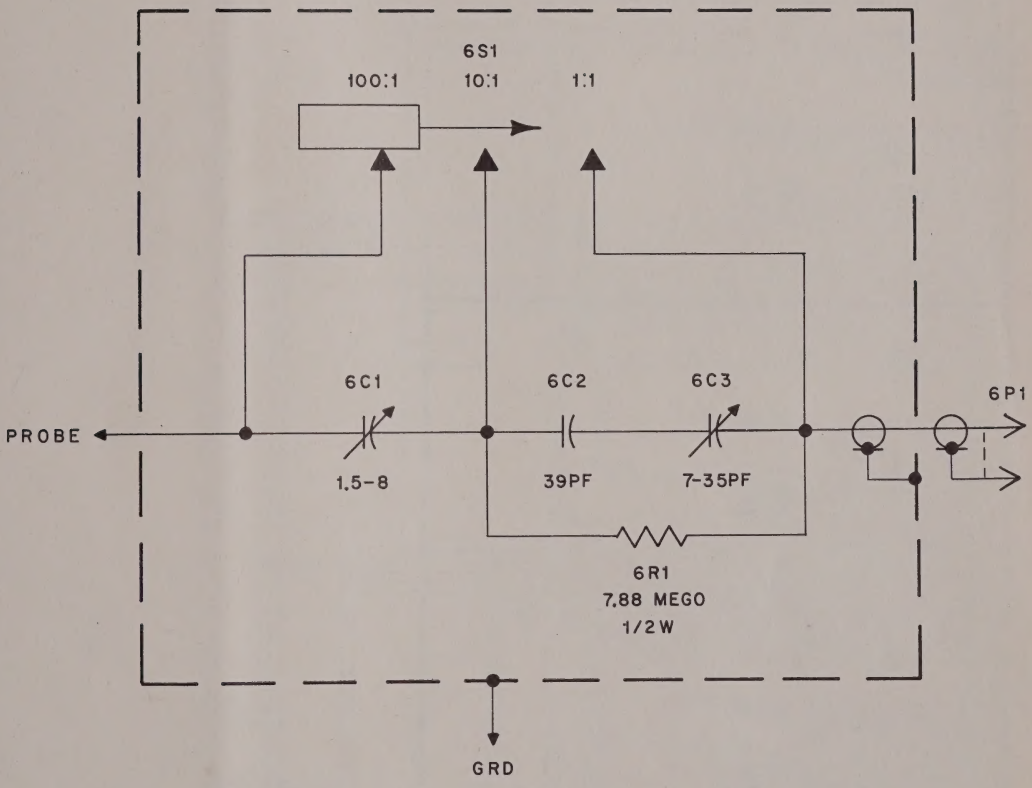


Figure 5-58. Test Lead MX-2631/UP,
Schematic Diagram

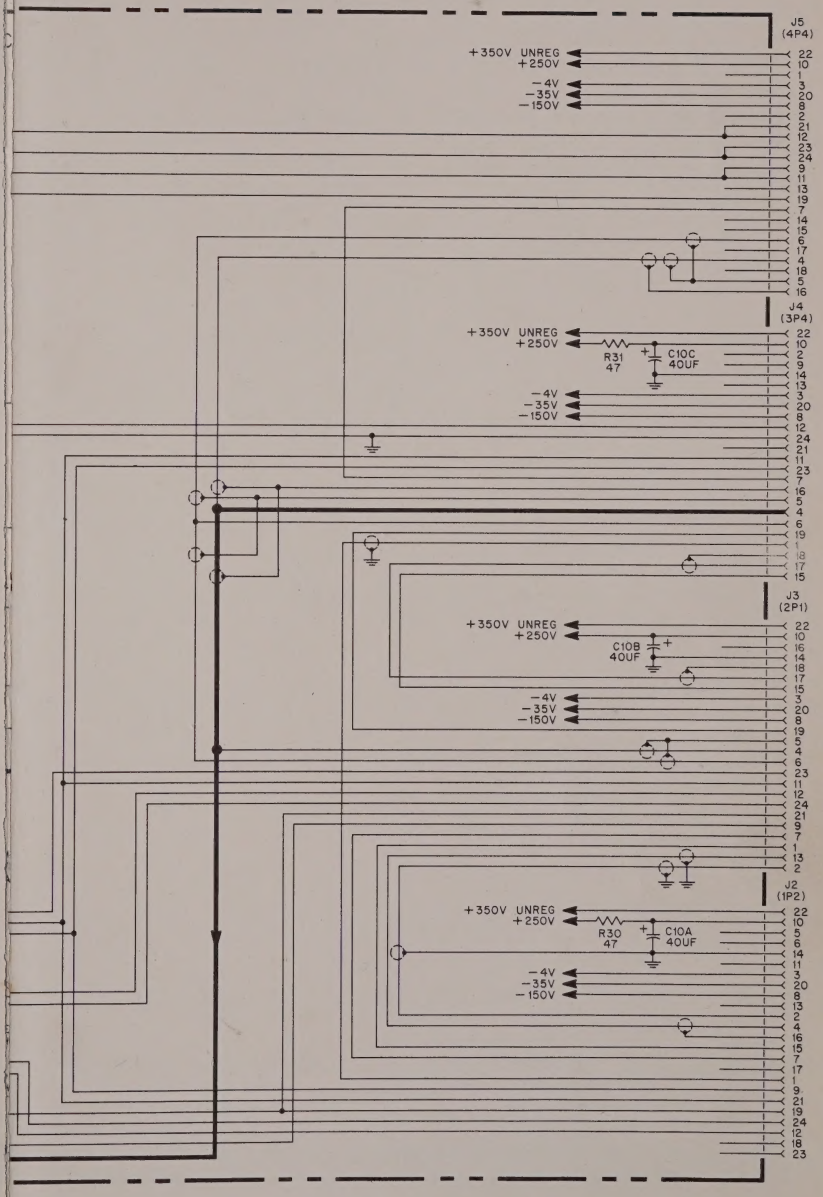


Figure 5-59. TS-1253A/UP Panel-Chassis Assembly, Schematic Diagram

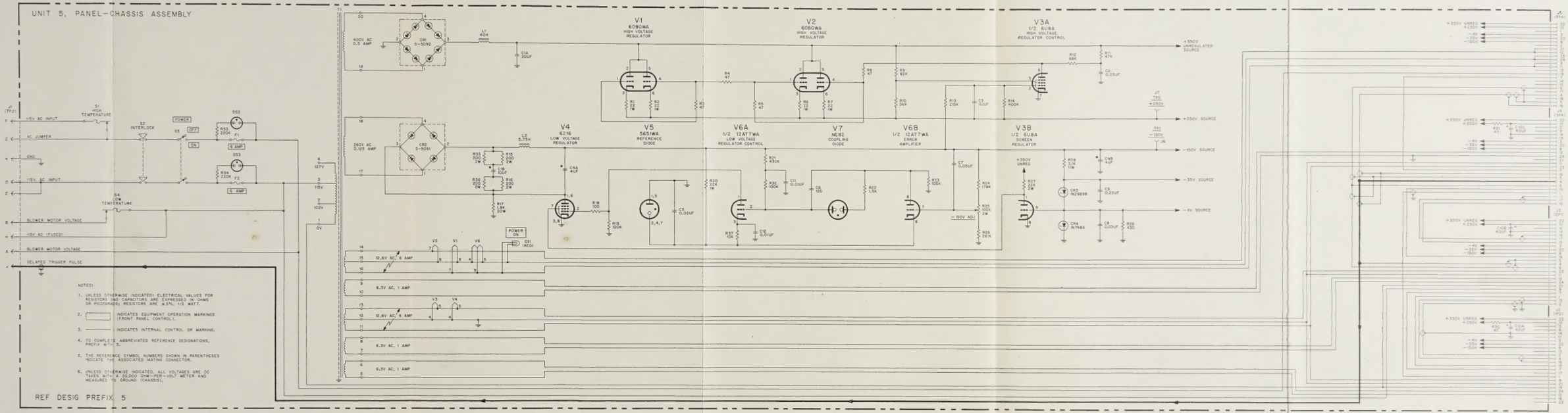


Figure 5-59. TS-1253A/UP Panel-Chassis Assembly, Schematic Diagram

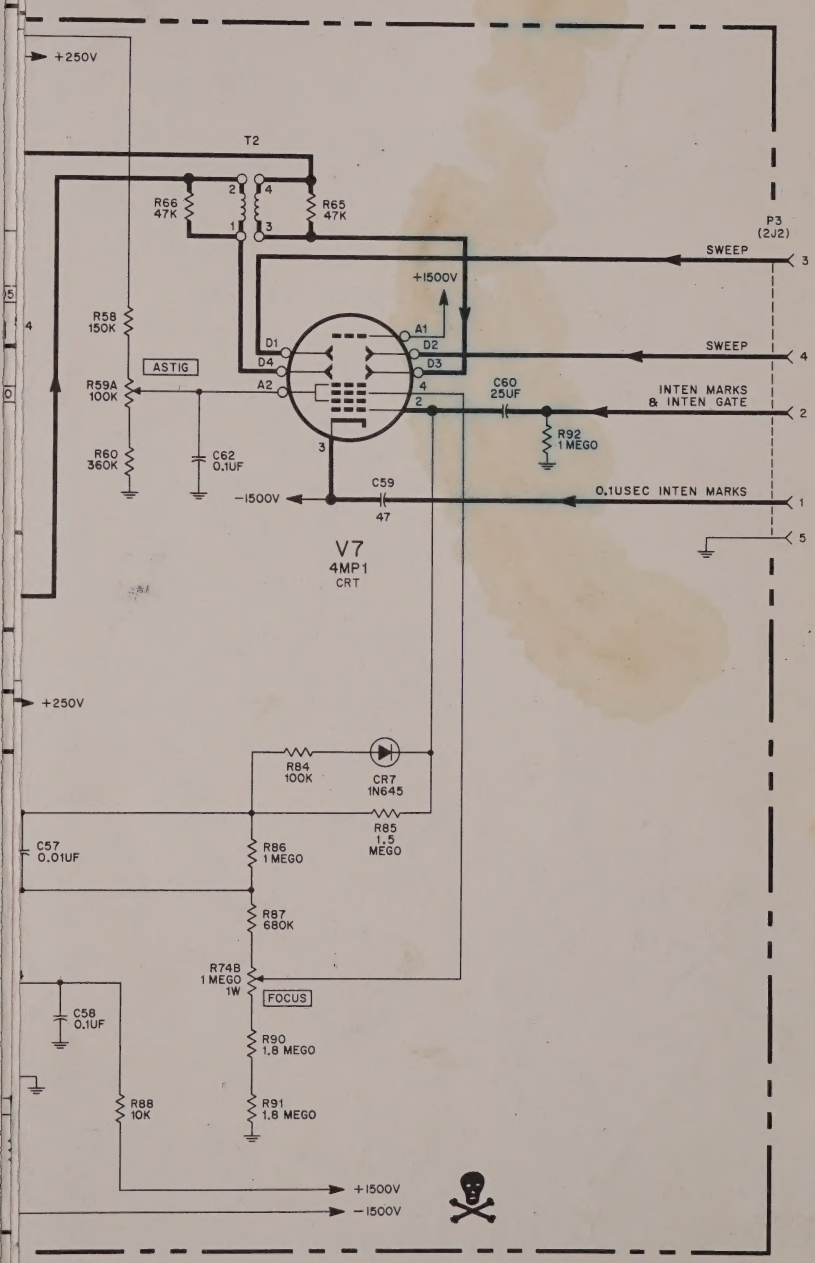
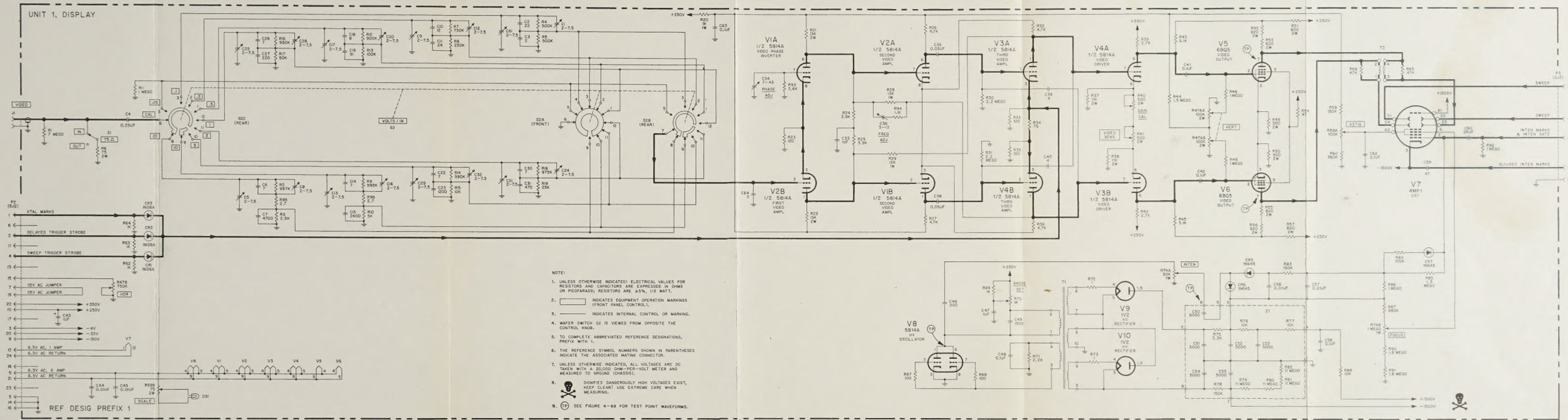


Figure 5-60. Display Unit,
Schematic Diagram



NOTE:

1. UNLESS OTHERWISE INDICATED: ELECTRICAL VALUES FOR RESISTORS AND CAPACITORS ARE EXPRESSED IN OHMS OR MICROFARADS; RESISTORS ARE ±5%, 1/2 WATT.
2. ▭ INDICATES EQUIPMENT OPERATION MARKINGS (FRONT PANEL CONTROL).
3. ——— INDICATES INTERNAL CONTROL OR MARKING.
4. WAFER SWITCH S2 IS VIEWED FROM OPPOSITE THE CONTROL KNOB.
5. TO COMPLETE ABBREVIATED REFERENCE DESIGNATIONS, PREFIX WITH 1.
6. THE REFERENCE SYMBOL NUMBERS SHOWN IN PARENTHESES INDICATE THE ASSOCIATED MATING CONNECTOR.
7. UNLESS OTHERWISE INDICATED, ALL VOLTAGES ARE DC TAKEN WITH A 20,000 OHM-PER-VOLT METER AND MEASURED TO GROUND (CHASSIS).
8. ⚠ SIGNIFIES DANGEROUSLY HIGH VOLTAGES EXIST, KEEP CLEAR! USE EXTREME CARE WHEN MEASURING.
9. (TP) SEE FIGURE 4-69 FOR TEST POINT WAVEFORMS.

Figure 5-60. Display Unit, Schematic Diagram

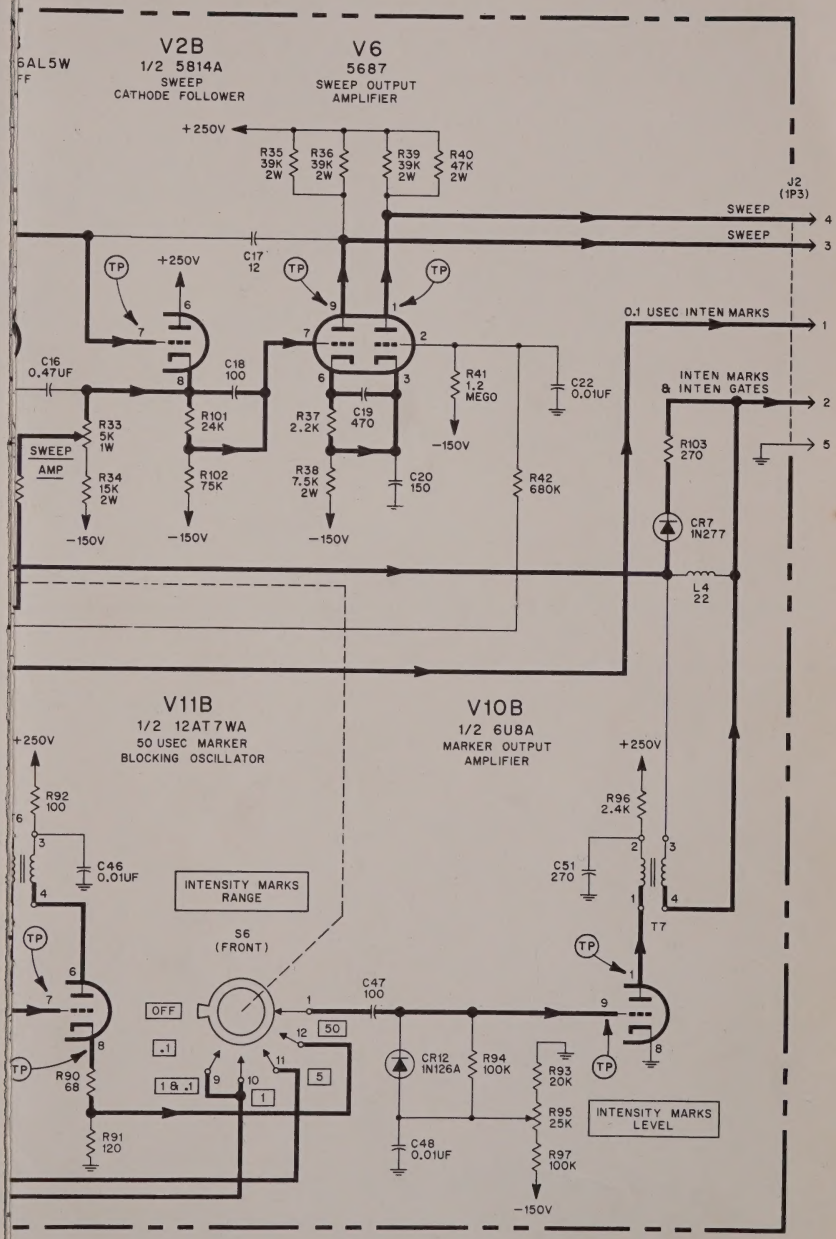


Figure 5-61. Sweep and Intensity Mark Unit, Schematic Diagram

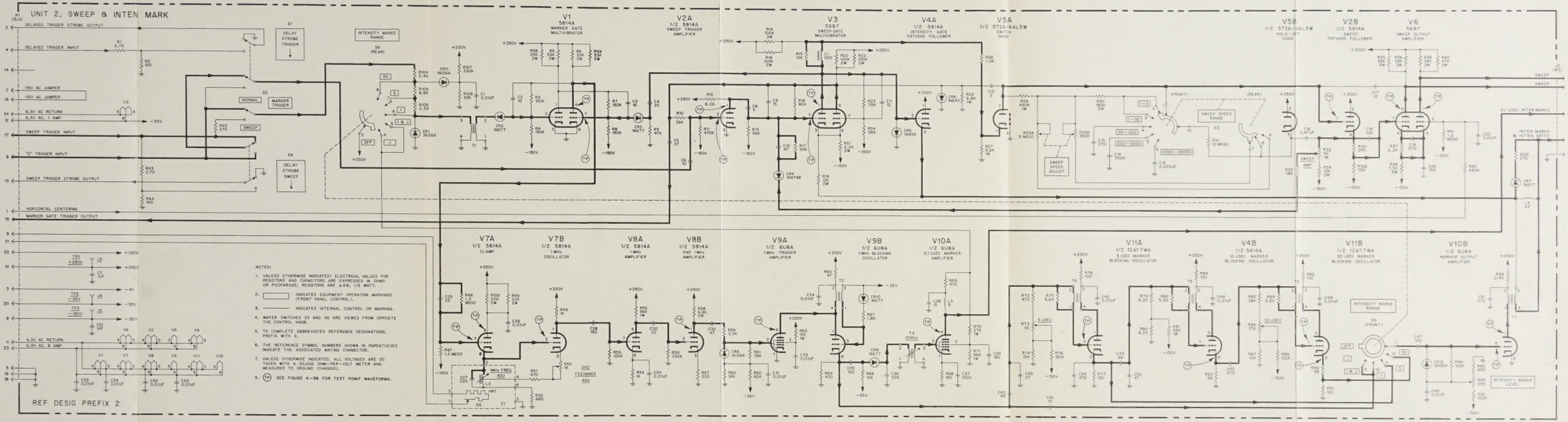


Figure 5-61. Sweep and Intensity Mark Unit, Schematic Diagram

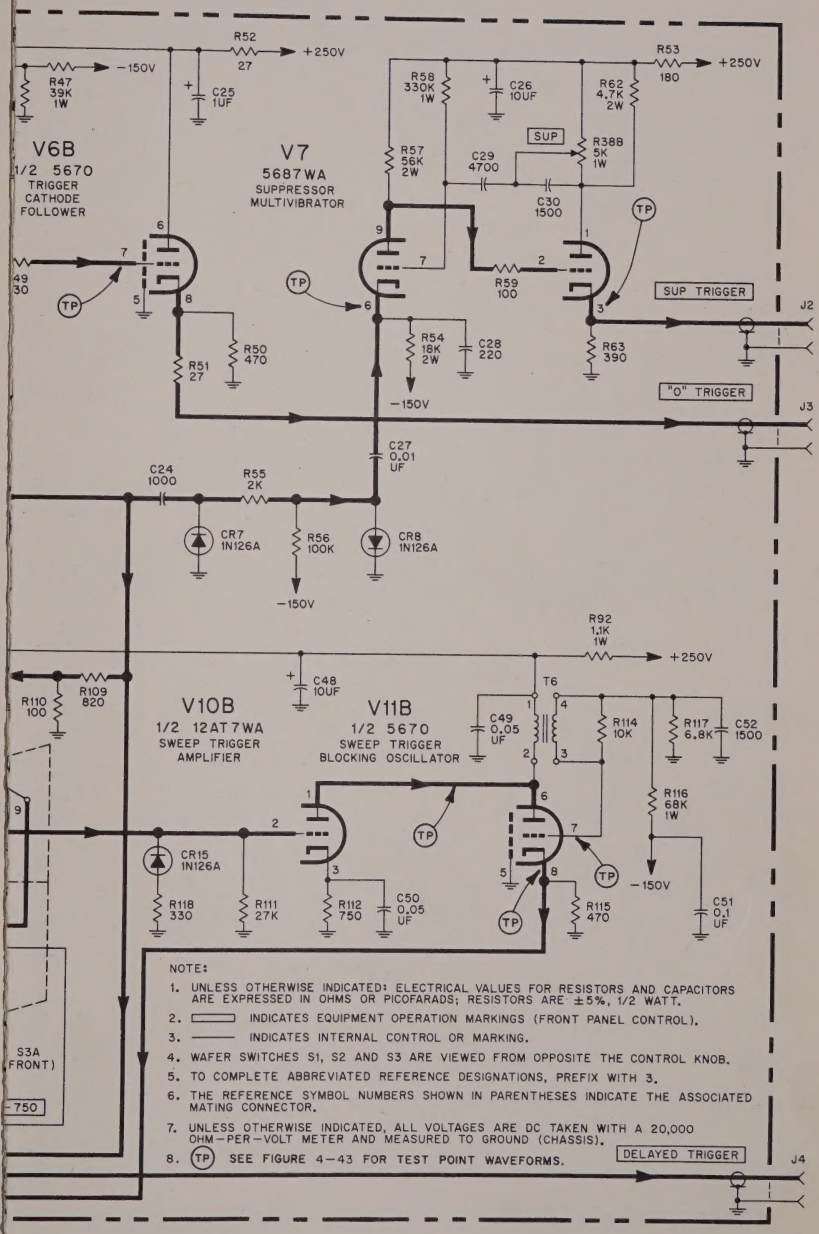


Figure 5-62. Crystal Mark and Sync Unit, Schematic Diagram

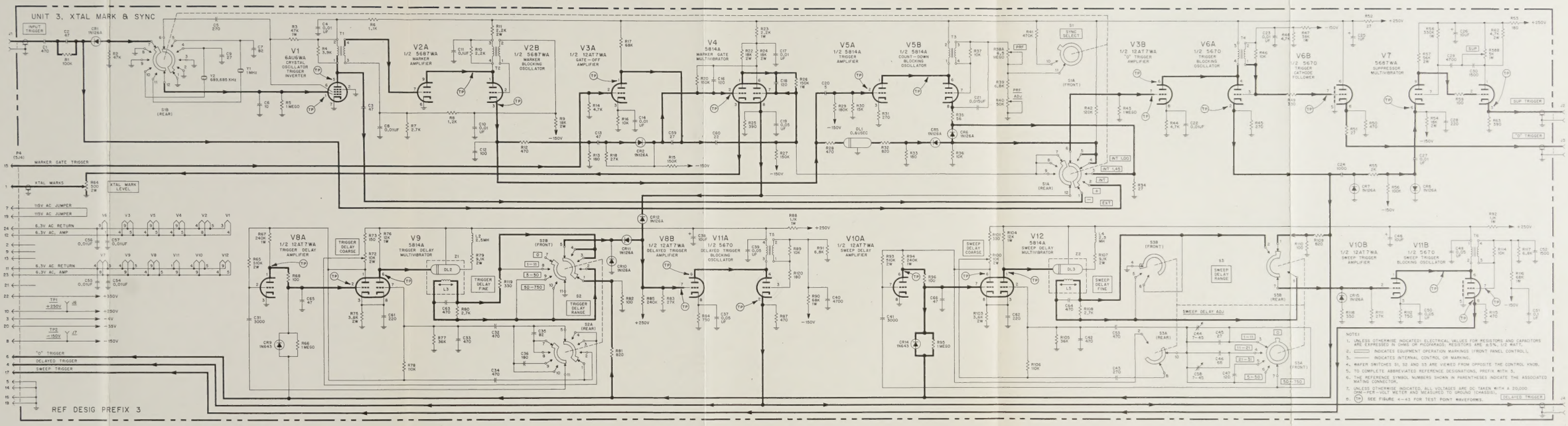


Figure 5-62. Crystal Mark and Sync Unit, Schematic Diagram

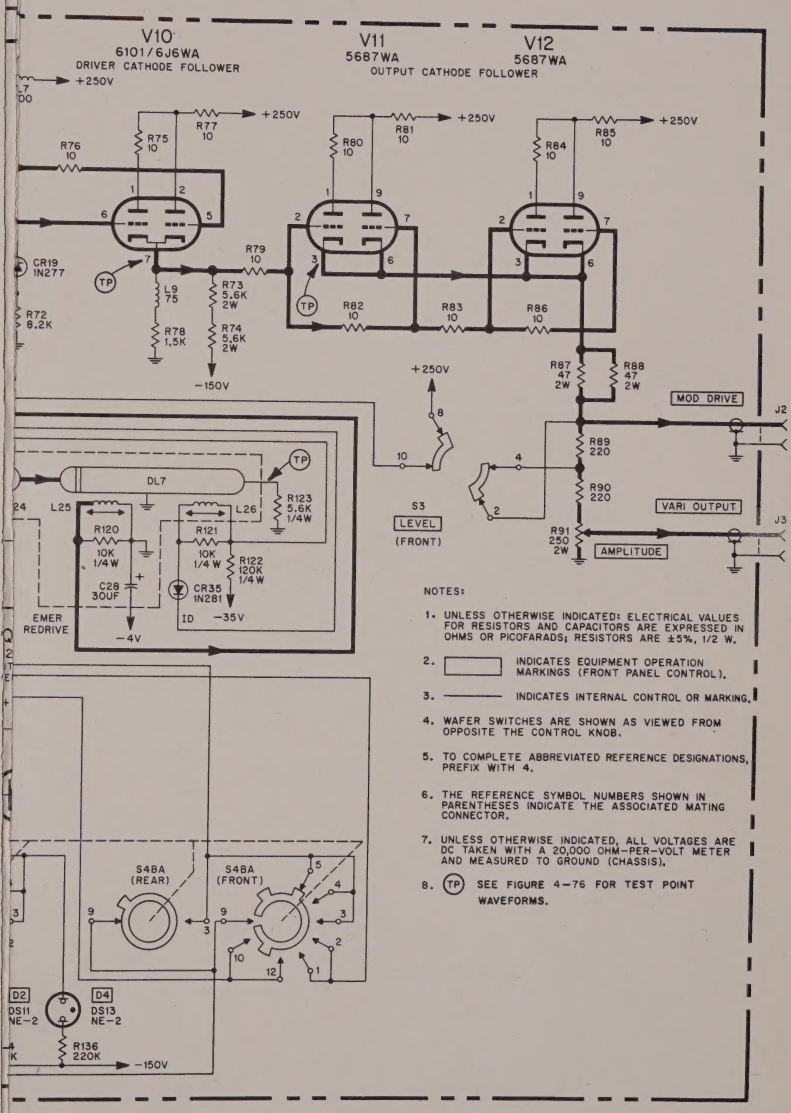
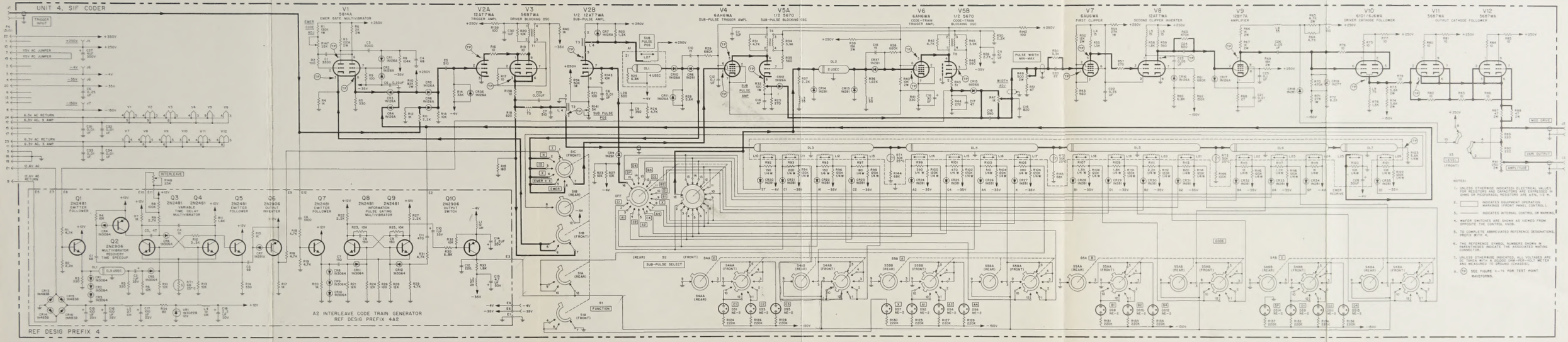


Figure 5-63. SIF Coder,
Schematic Diagram


UNIT 4, SIF CODER
REF DESIG PREFIX 4
A2 INTERLEAVE CODE TRAIN GENERATOR
REF DESIG PREFIX 4A2
V1 5814A
V2A 12AT7WA
V3 5687WA
V2B 1/2 12AT7WA
V4 6AH6WA
V5A 1/2 5670
V6 6AH6WA
V5B 1/2 5670
V7 6AU6WA
V8 12AT7WA
V9 12BY7A
V10 6197/6JK6A
V11 5687WA
V12 5687WA
Q1 2N2481
Q2 2N2906
Q3 2N2481
Q4 2N2481
Q5 2N2481
Q6 2N2905
Q7 2N2481
Q8 2N2481
Q9 2N2481
Q10 2N2906
S1A (REAR)
S1A (FRONT)
S1B (REAR)
S1B (FRONT)
S1C (FRONT)
S2 (REAR)
S2 (FRONT)
S4A (REAR)
S4A (FRONT)
S4B (REAR)
S4B (FRONT)
S5A (REAR)
S5A (FRONT)
S5B (REAR)
S5B (FRONT)
S6A (REAR)
S6A (FRONT)
S6B (REAR)
S6B (FRONT)
S7A (REAR)
S7A (FRONT)
S7B (REAR)
S7B (FRONT)
S8A (REAR)
S8A (FRONT)
S8B (REAR)
S8B (FRONT)

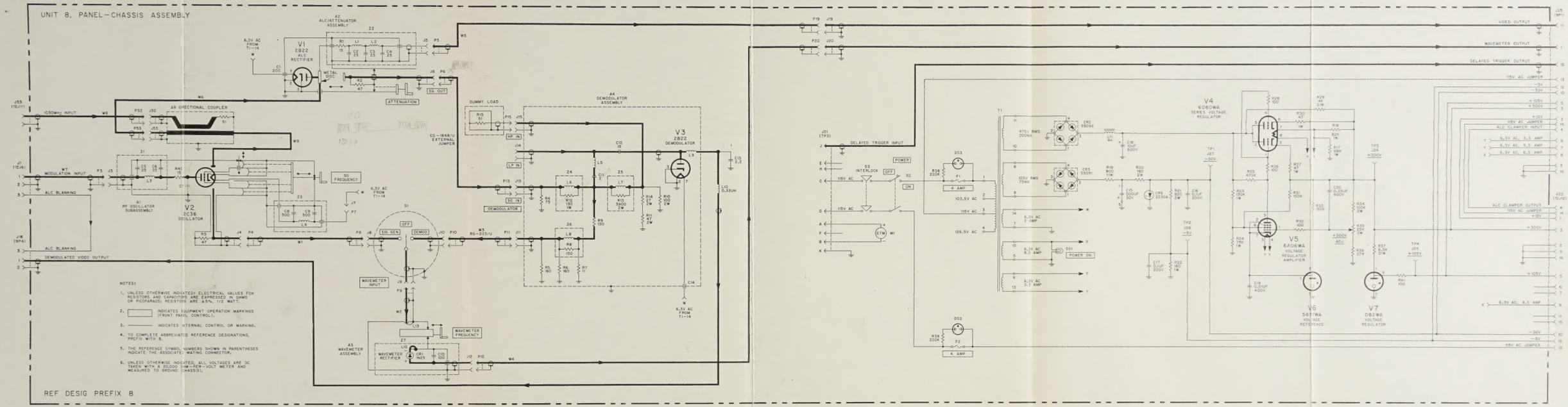


Figure 5-64. SM-197A/UPM-98, Panel-Chassis Assembly, Schematic Diagram

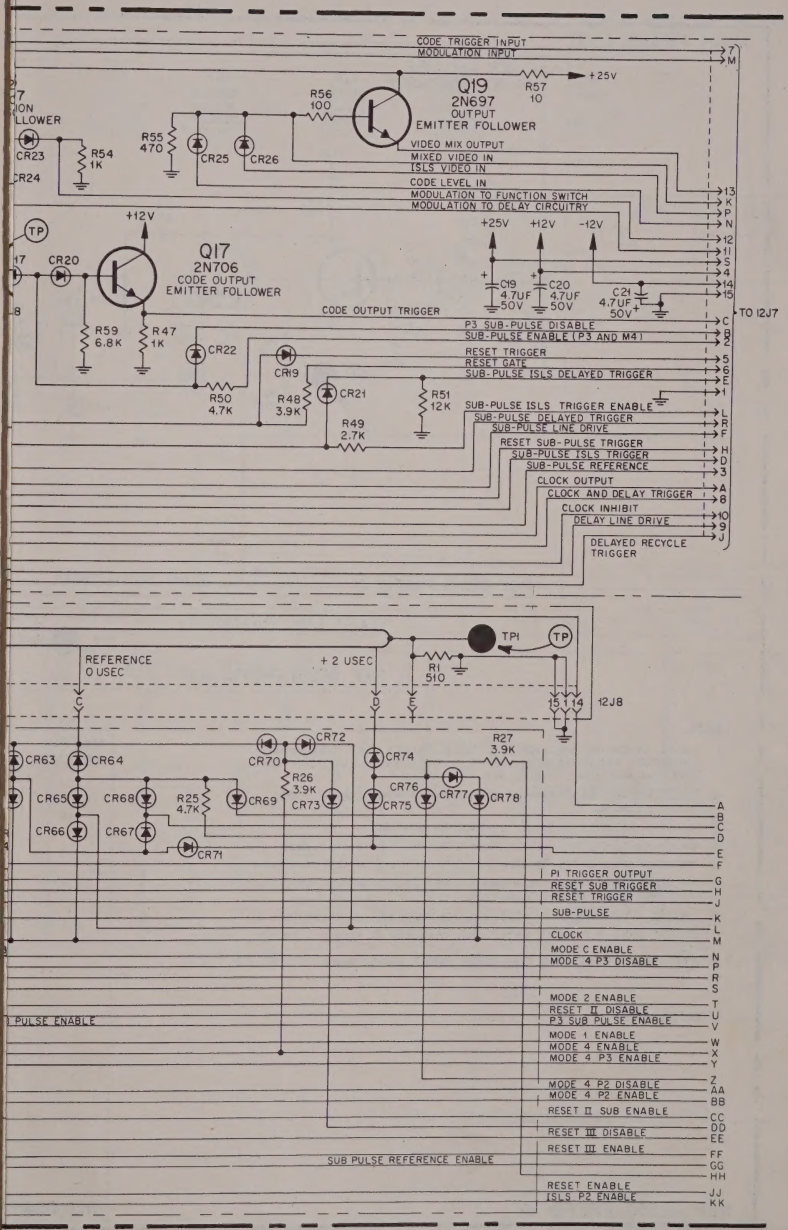


Figure 5-65. Interrogation Coder, Schematic Diagram
(Sheet 1 of 3)

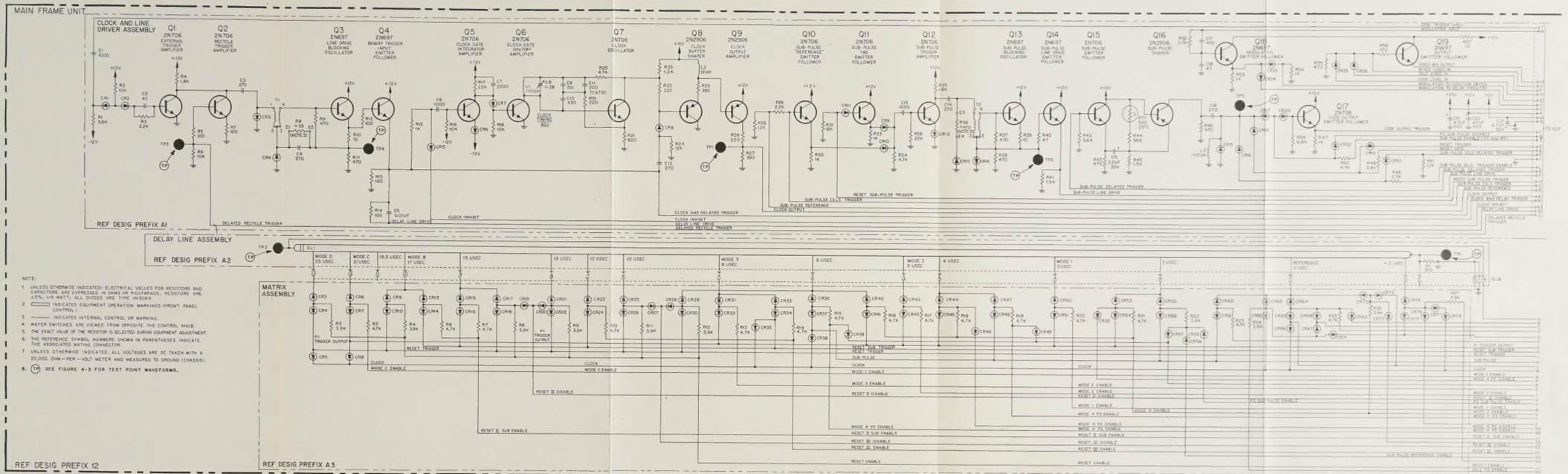


Figure 5-65. Interrogation Coder, Schematic Diagram (Sheet 1 of 3)

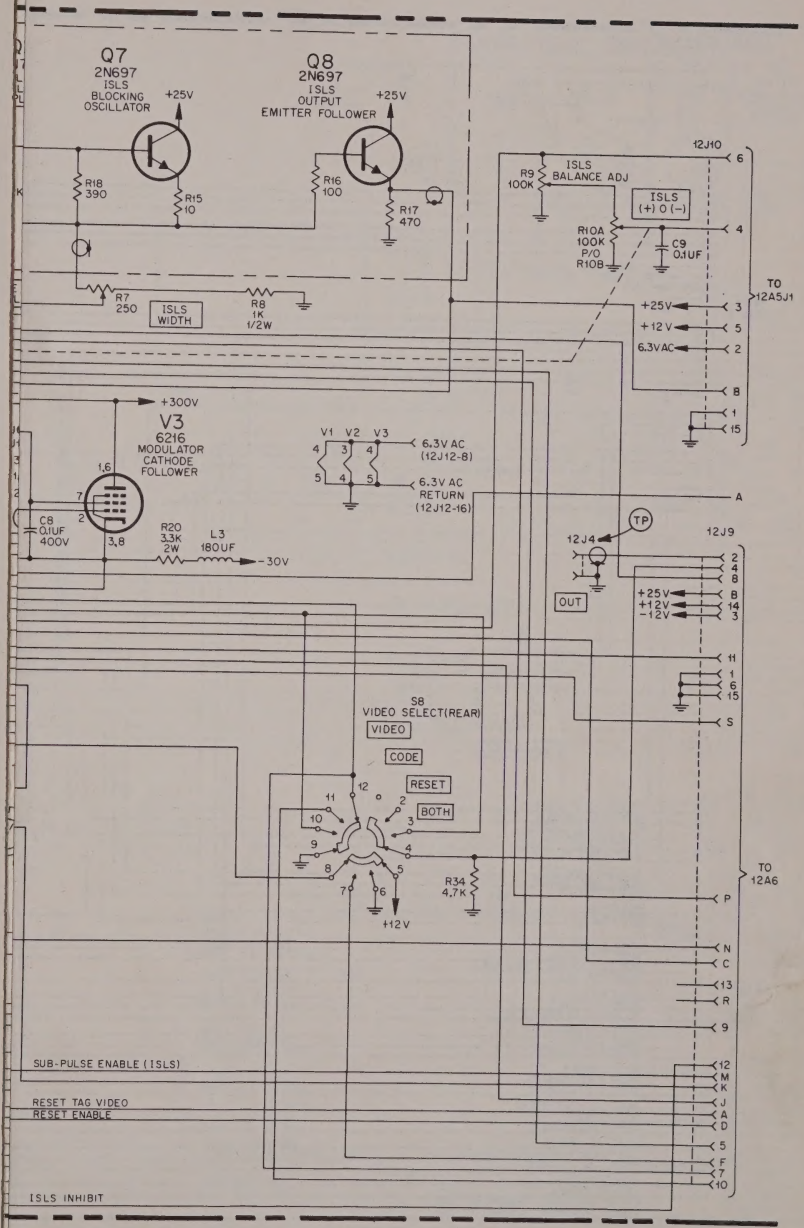


Figure 5-65. Interrogation Coder, Schematic Diagram
(Sheet 2 of 3)

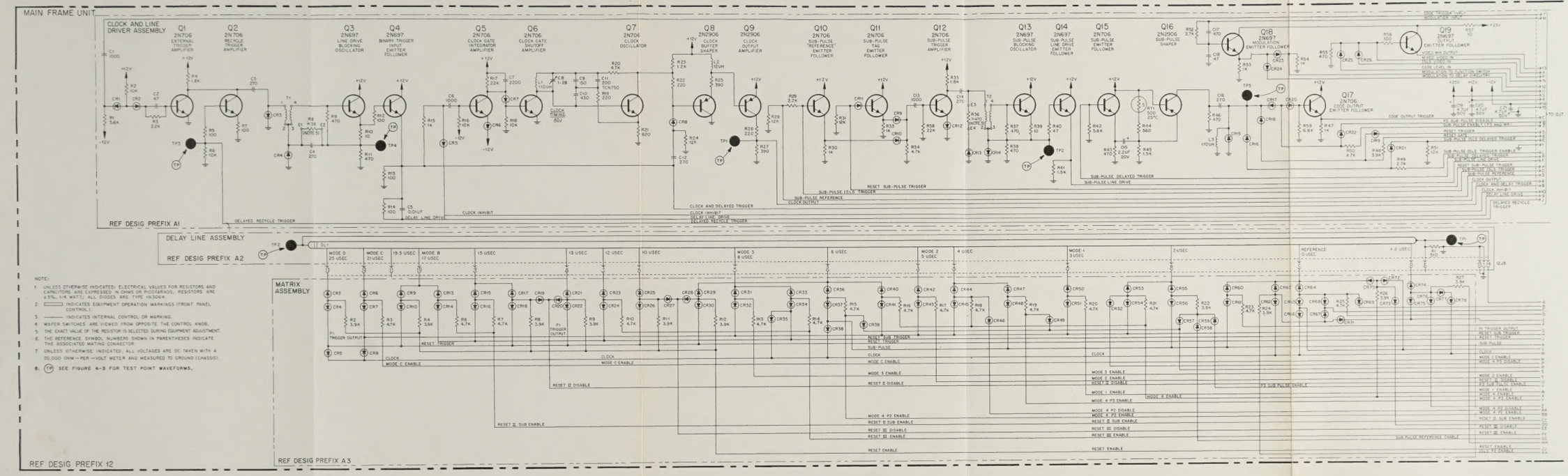


Figure 5-65. Interrogation Coder, Schematic Diagram
(Sheet 1 of 3)

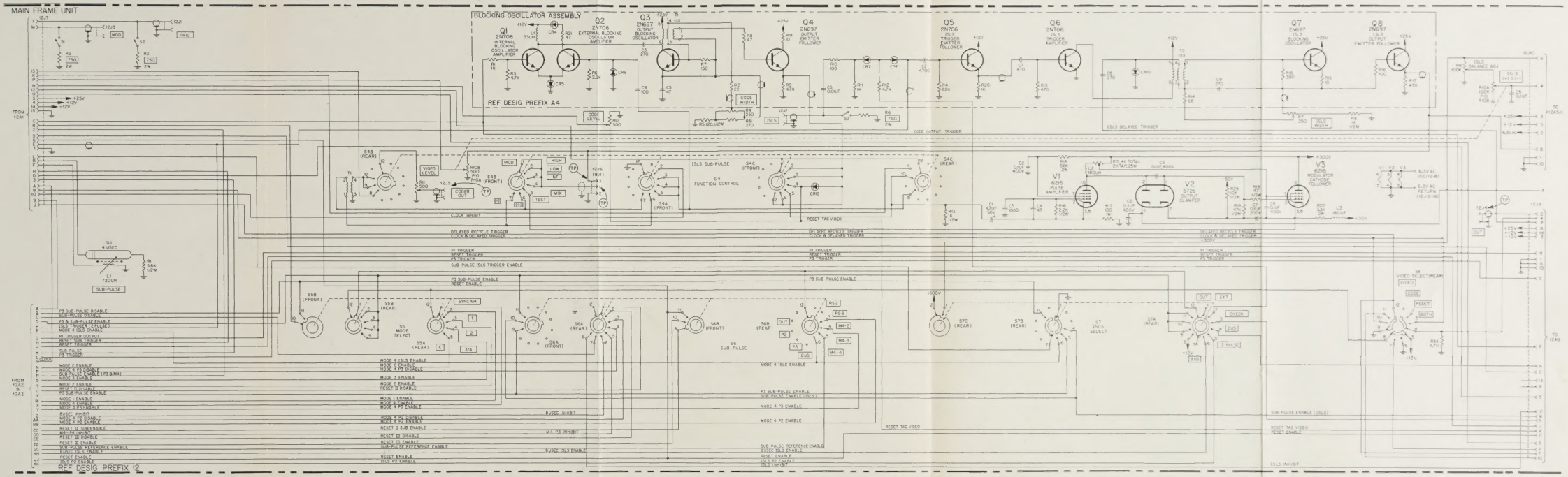


Figure 5-65. Interrogation Coder, Schematic Diagram (Sheet 2 of 3)

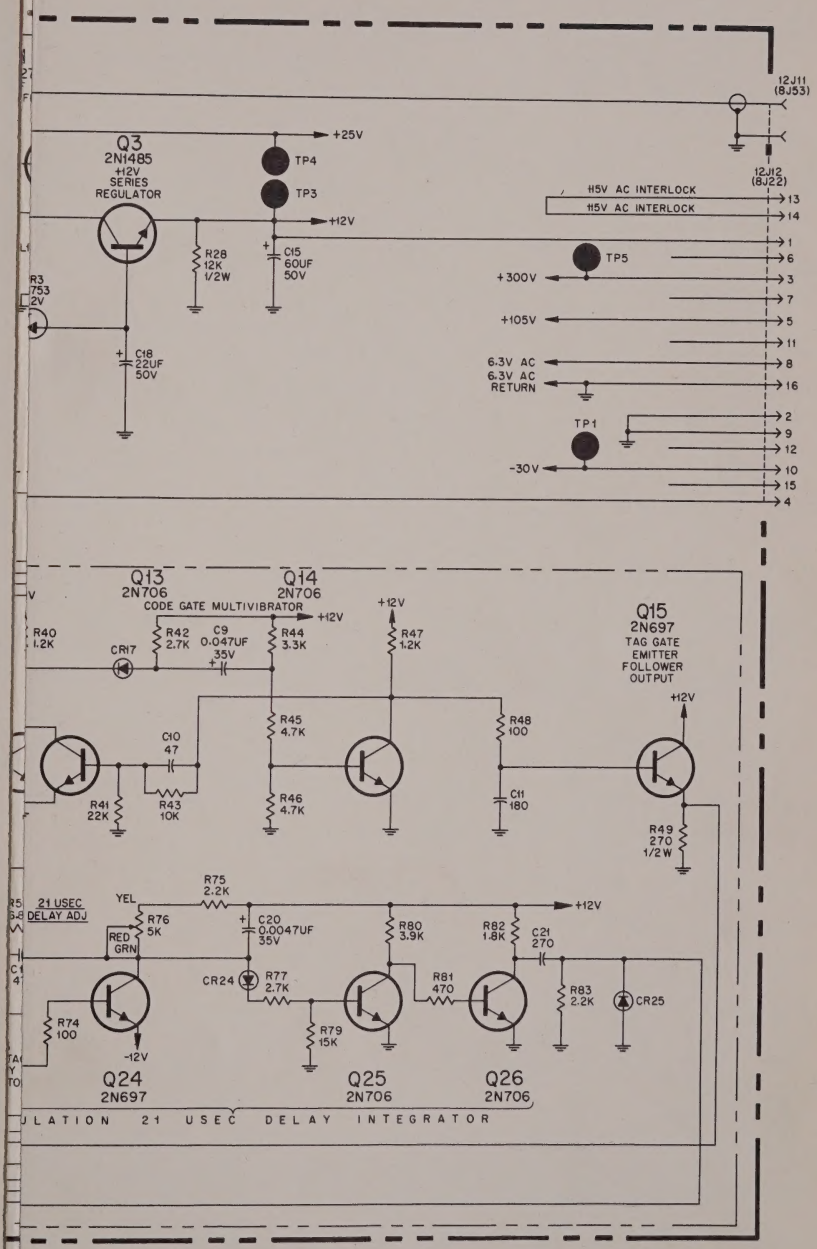


Figure 5-65. Interrogation Coder, Schematic Diagram
(Sheet 3 of 3)

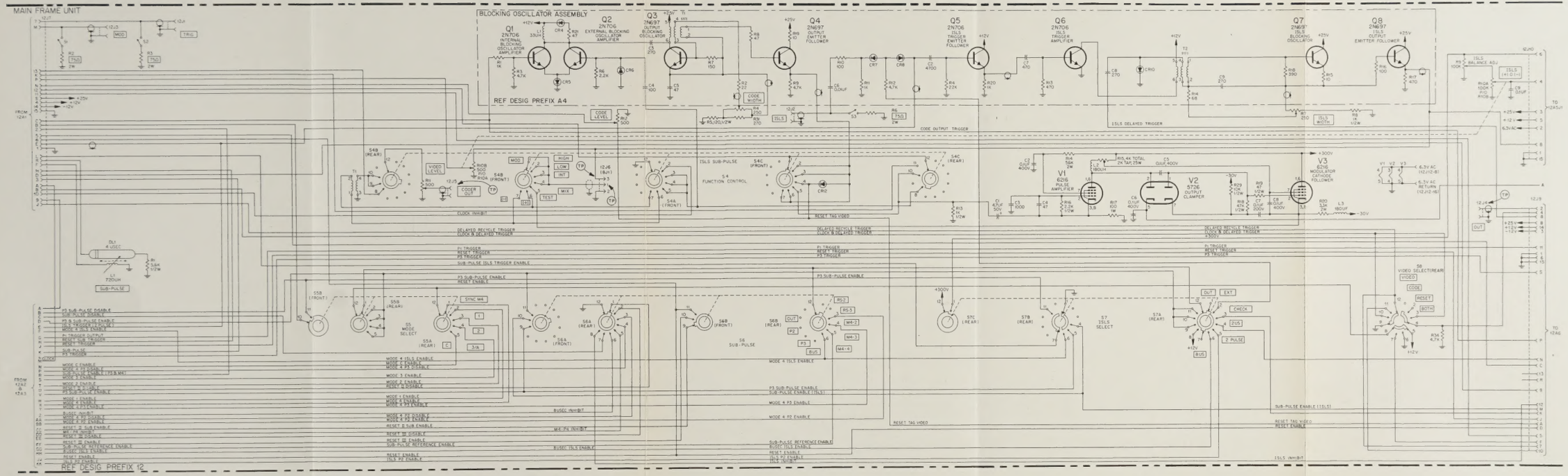


Figure 5-65. Interrogation Coder, Schematic Diagram (Sheet 2 of 3)

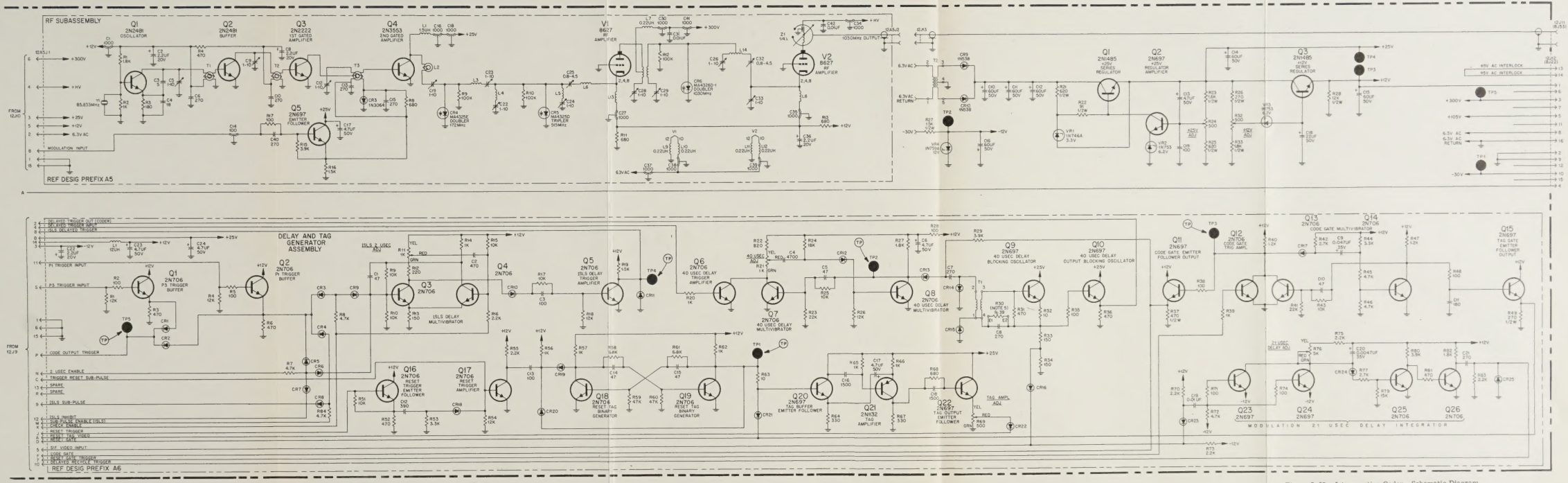


Figure 5-65. Interrogation Coder, Schematic Diagram
(Sheet 3 of 3)

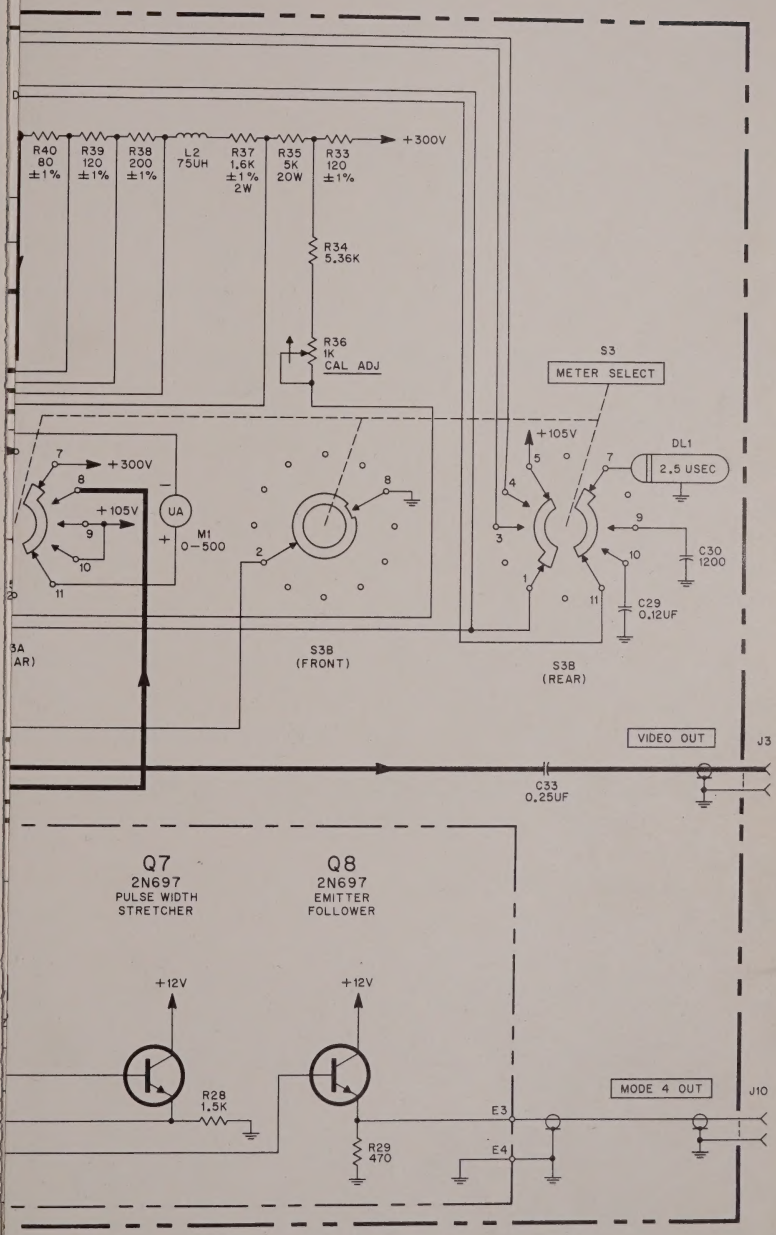


Figure 5-66. Calibration-Control Unit, Schematic Diagram

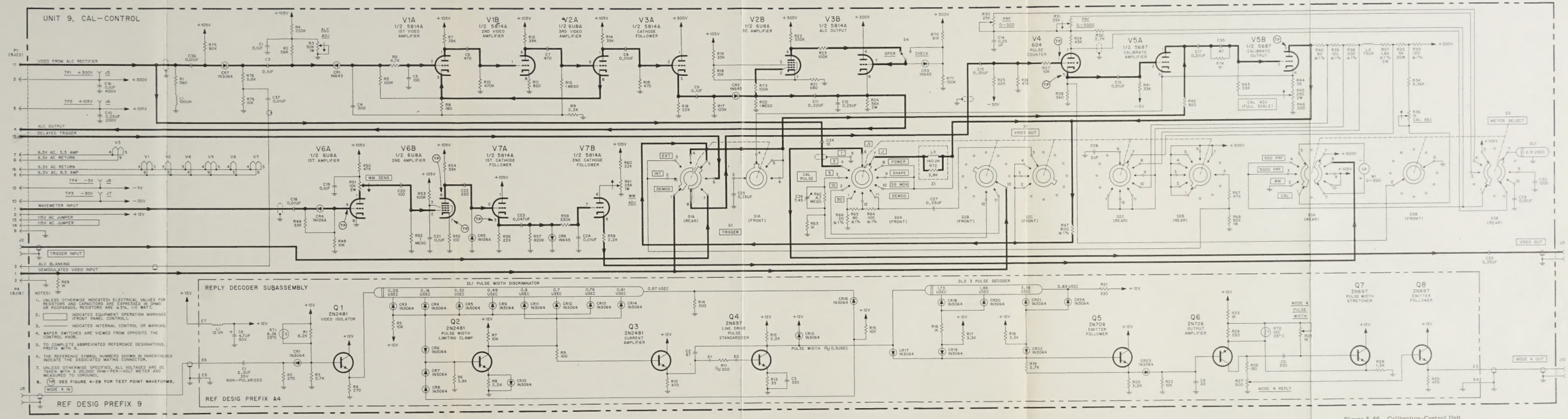


Figure 5-66. Calibration-Control Unit, Schematic Diagram

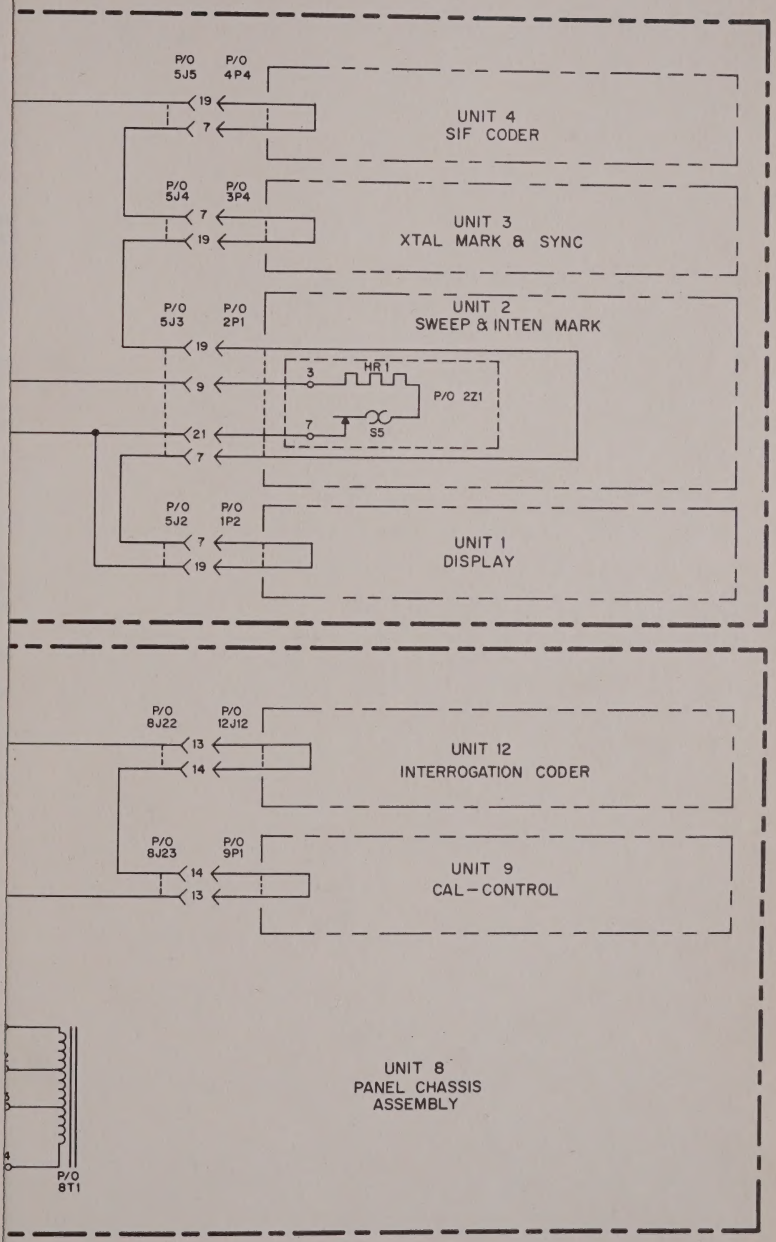


Figure 5-67. Radar Test Set AN/UPM-98A,
Power Distribution Diagram

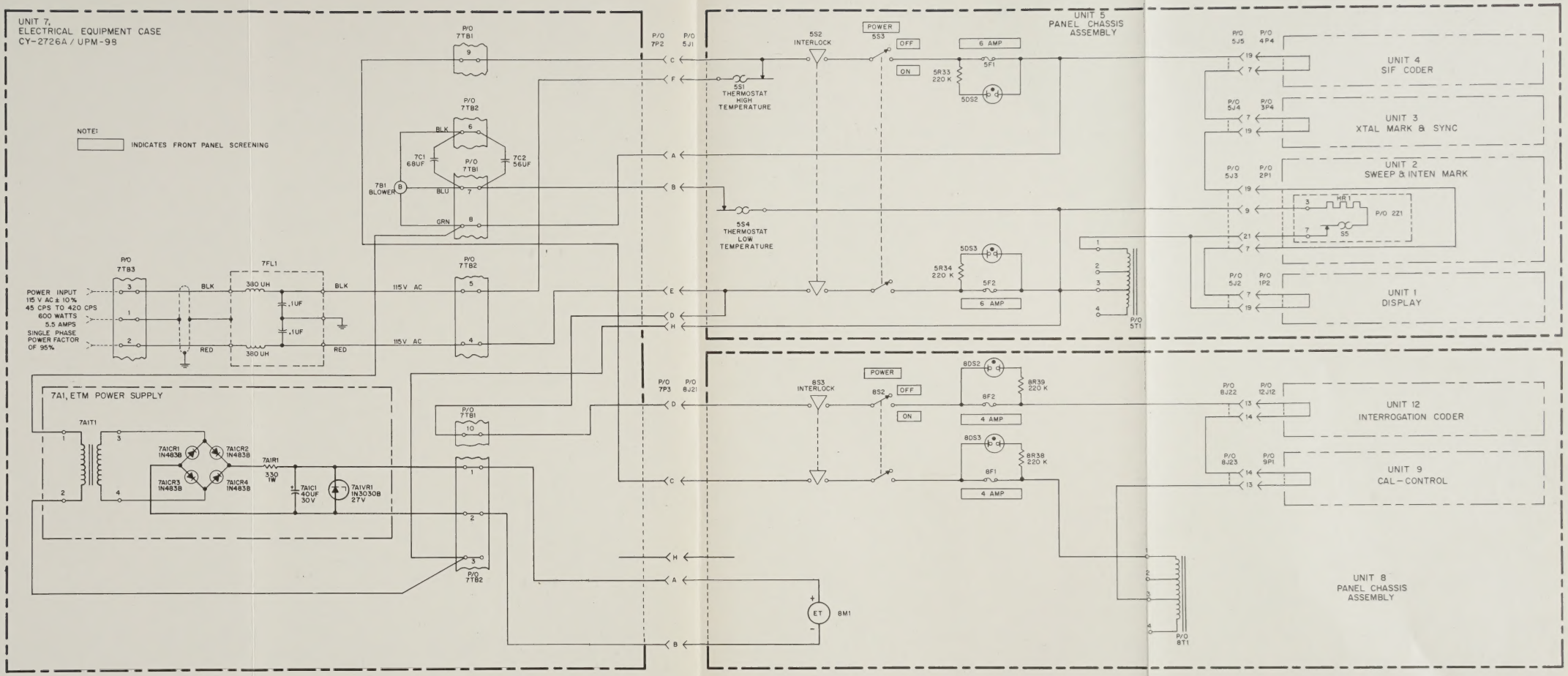


Figure 5-67. Radar Test Set AN/UPM-98A, Power Distribution Diagram

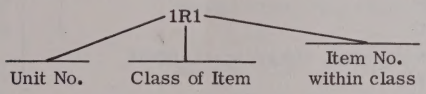
SECTION 6

MAINTENANCE PARTS LIST

6-1. INTRODUCTION.

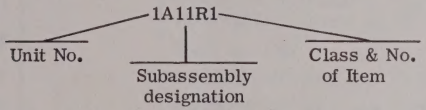
a. REFERENCE DESIGNATIONS. - The unit numbering method of assigning reference designations has been used to identify units, assemblies, subassemblies, and parts. Examples of this unit numbering methods are illustrated by the following:

EXAMPLE 1:



Read as: First (1) resistor (R) of first unit (1).

EXAMPLE 2:



Read as: First (1) resistor (R) of eleventh (11) subassembly (A) of first (1) unit.

b. REF DESIG PREFIX. - Partial reference designations are used on the equipment and illustrations. The partial reference designations consist of the class letter (s) and the identifying item number. The complete reference designations may be obtained by placing the proper prefix before the partial reference designations.

6-2. LIST OF UNITS.

Table 6-1 is a listing of the units compromising the equipment. The units are listed by unit numbers in numerical order. Thus, when the complete reference designation of a part is known, this table will furnish the identification of the unit in which the part is located, since the first number of a complete reference designation identifies the unit. Table 6-1 also provides the following information for each unit listed: quantity per equipment, official name, designation, location of the first page of its parts listing in table 6-2.

6-3. MAINTENANCE PARTS LIST.

Table 6-2 lists all units and their maintenance parts. The units are listed in numerical sequence. Maintenance parts for each unit are listed alphabetically-numerically by reference designation. The parts for each unit are listed grouped together. Table 6-2 provides the complete reference designation of each unit, noun name and brief description, and identification of the illustration which pictorically locates the part.

6-4. LIST OF MANUFACTURERS.

Table 6-3 lists the manufacturers of parts used in the equipment. The table includes the manufacturer's code used in table 6-2 to identify the manufacturers.

6-5. STOCK NUMBER IDENTIFICATION.

Allowance Parts List (APL) issued by the Electronics Supply Office (ESO) include Federal Stock Numbers and Source Maintenance and Recoverability Codes. Therefore, reference should be made to the APL prepared for the equipment for stock numbering information.

TABLE 6-1. LIST OF UNITS

UNIT NO.	QTY	NAME OF UNIT	NOMENCLATURE	PAGE NO.
		Test Set Radar	TS-1843A/UP	
1	1	Display		6-2
2	1	Sweep & Inten Mark		6-9
3	1	Xtal Mark & Sync		6-16
4	1	SIF Coder		6-24
5	1	Main Chassis		6-35
6	1	Test Lead	MX-2681/UP	6-40
7	1	Case, Electrical	CY-2726A/UPM-98	6-42
		Coder Simulator	SM-197A/UPM-98	
8	1	Main Chassis		6-43
9	1	Cal-Control		6-50
12	1	Inter Coder		6-57

TABLE 6-2. MAINTENANCE PARTS LIST

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1-5		TEST SET, RADAR TS-1253A/UP, Mfr 70117, PN GJ4709	5-24
1		DISPLAY UNIT: Mfr 70117, PN GJ4897	5-24
1A1		MOUNTING ASSEMBLY: Mfr 70117, PN GC1586-1	5-28
1A2		ATTENUATOR ASSEMBLY: Mfr 70117, PN GC2015-2	5-29
1C1		CAPACITOR, VARIABLE: Ceramic, mfr 71590, PN DA 1053-002; (Admiral PN 566B6-1)	5-28
1C2		CAPACITOR: MIL type CC21CH220G	5-29
1C3		CAPACITOR: MIL type CC21CK020C	5-29
1C4		CAPACITOR, FIXED, PAPER: 0.25 μf, ±20%, 600 vdcw; mfr 00656, PN P8292ZN; (Admiral PN 565D45-24)	5-29
1C5		Same as 1C1	5-28
1C6		CAPACITOR: MIL type CC21CH070C	5-29
1C7		CAPACITOR: MIL type CM06F472G03	5-29
1C8 & 1C9		Same as 1C1	5-28
1C10		CAPACITOR: MIL type CC20CH120G	5-29
1C11		CAPACITOR: MIL type CC21CH240G	5-29
1C12 & 1C13		Same as 1C1	5-28
1C14		Same as 1C6	5-29
1C15		CAPACITOR: MIL type CM06F242G03	5-29
1C16 & 1C17		Same as 1C1	5-28
1C18		CAPACITOR: MIL type CM21CH080C	5-29
1C19		CAPACITOR: MIL type CM05F910G03	5-29
1C20 & 1C21		Same as 1C1	5-28
1C22		Same as 1C6	5-29
1C23		CAPACITOR: MIL type CM06F122G03	5-29
1C24 & 1C25		Same as 1C1	5-28
1C26		Same as 1C6	5-29
1C27		CAPACITOR; MIL type CM05F221J03	5-29
1C28 & 1C29		Same as 1C1	5-28

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1C30		Same as 1C6	5-29
1C31		CAPACITOR: MIL type CM06F471G03	5-29
1C32		Same as 1C1	5-28
1C33		CAPACITOR: MIL type CH12A3NE105K	5-28
1C34		CAPACITOR, VARIABLE: MIL type CV11D450	5-28
1C35		CAPACITOR, FIXED, PAPER: 0.05 μf, ±20%, 400 vdcw; mfr 00656, PN P8292ZN; (Admiral PN 565D45-13)	5-27
1C36		CAPACITOR, VARIABLE: MIL type CV11B130	5-28
1C37		Not Used	
1C38		Same as 1C35	5-27
1C39		CAPACITOR: MIL type CC21CH040C	
1C40		Same as 1C39	5-27
1C41		CAPACITOR, FIXED, PAPER: 0.1 μf, ±20%, 400 vdcw; mfr 00656, PN P8292ZN; (Admiral PN 565D45-14)	5-27
1C42		Same as 1C41	5-27
1C43		CAPACITOR: MIL type CP11A3KE105K3	5-28
1C44		CAPACITOR: MIL type CK63AY103X	5-27
1C45		Same as 1C44	5-27
1C46		CAPACITOR: MIL type CM05F201J03	5-27
1C47		Same as 1C33	5-28
1C48		CAPACITOR, FIXED, PAPER: 0.1 μf, ±20%, 200 vdcw; mfr 00656, PN P8292ZN; (Admiral PN 565D45-5)	5-27
1C49		CAPACITOR: MIL type CM06F152J03	5-27
1C50 thru 1C55		For reference only	5-27
1C56 & 1C57		Same as 1C44	5-27
1C58		CAPACITOR, FIXED, PLASTIC: 0.1 μf, ±10%, 2000 vdcw; mfr 56289, PN P8827; (Admiral PN 565B63)	5-28
1C59		CAPACITOR, FIXED, CERAMIC: 47 pf, ±10%, 3000 vdcw; mfr 70117, PN 565C1-11	5-30
1C60		CAPACITOR, FIXED, PLASTIC: 0.25 μf, ±10%, 2000 vdcw; mfr 99120, PN OF-20-254KT; (Admiral PN 565B62)	5-30
1C61		Same as 1C1	5-28
1C62 & 1C63		Same as 1C41	5-27
1C64		Same as 1C3	5-27

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1CR1 thru 1CR3		SEMICONDUCTOR DIODE: MIL type 1N126A	5-27
1CR4		Not Used	
1CR5 thru 1CR7		SEMICONDUCTOR DIODE: MIL type 1N645	5-27
1DS1		LAMP, INCANDESCENT: 6 volt, 0.2 amperes, T- 1-3/4 bulb, single contact, midget flange; mfr 24455, PN 328R; (Admiral PN 581A2-5)	5-27
1E1		TERMINAL, STUD: Threaded, hex shoulder, 4-40x5/16 in. thread; mfr 71279, PN 4531; (Admiral PN 509B30-6)	5-28
1E2		TERMINAL, INSULATED: Mfr 98291, PN ST-SM-22TUR; (Admiral PN 510B3-10)	5-28
1E3		TERMINAL, INSULATED: Mfr 98291, PN ST-SM-22TUR; (Admiral PN 510B3-11)	5-28
1E4		TERMINAL, STRIP: Mfr 70117, PN 515A888	5-28
1E5		TERMINAL, STRIP: Mfr 70117, PN 515B889	5-28
1E6		TERMINAL, STRIP: Mfr 70117, PN 515A953-2	
1E7		TERMINAL, STRIP: Mfr 70117, PN 515A951-1	
1E8		SHIELDING, GASKET: Mfr 07700, PN 13205; (Admiral PN 536B28-2)	5-27
1E9		SHIELD, TUBE: Mfr 70117, PN 585D5-2	5-28
1E10		SHIELD, TUBE: Mfr 70117, PN 585C6-6	5-28
1E11		SHIELD, TUBE: MIL type TS103U02	5-28
1E12		CLIP, ELECTRICAL: Mfr 70117, PN 590A5-1	5-28
1E13		INSULATOR PLATE: Mfr 70117, PN 532A294	
1E14		TERMINAL, STUD: Plastic body with terminal one end and 6-32 thd, 5/32 in. deep other end; mfr 92825, PN 2A10-A1; (Admiral PN 509A21-1)	
1H1		WASHER, NONMETALLIC: 1/8 in. fibre 7/32 in. od 0.120 in. id; mfr 70117, PN 505D1-4	
1H2		PIN, SPRING: MIL type MS171435	
1H3		INSERT, SCREW: Stainless steel, .187 in. dia 3/16 in. lg, 2-56 thd thru center; mfr 70117, PN 527A468	
1J1		CONNECTOR, RECEPTACLE: MIL type UG-625B/U	5-28
1MP1		CLAMP, LOOP: 5/8 in. dia black nylon; mfr 95987, PN WC 5/8-6; (Admiral PN 511D7-56)	
1MP2		CLAMP, LOOP: 3/8 in. dia white nylon; mfr 71616, PN CPC-1953-B6; (Admiral PN 511D7-25)	
1MP3		BUSHING, SHAFT: Panel mtg, hex head with 3/8-32 thread, .555 in. overall length; mfr 71450, PN H545B-10B; (Admiral PN 588B86-1)	5-28
1MP4		GROMMET: Neoprene, mfr 70485, PN 54G; (Admiral PN 512D12-10)	
1MP5		RUBBER, STRIP: Neoprene black sponge, 1/4 in. thk, 1/4 in. w, 1-1/4 in. lg; mfr 70117, PN 512D18-56	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1MP6		GROMMET: Neoprene, black; mfr 75543, PN 807; (Admiral PN 512D12-30)	
1MP7		RUBBER, STRIP: Neoprene, black sponge, 1/4 in. thk, 1/4 in. w, 17/32 in. lg; mfr 70117, PN 512D18-58	
1MP8		RUBBER, CHANNEL: Neoprene, black "U" shape 7/64 in. thk, 7/32 in. w, 6-7/16 in. lg; mfr 70117, PN 512A63-7	
1MP9		GASKET: Black neoprene; 1/32 in. thk, 1.062 in. dia, 13/16 in. hole in center; mfr 70117, PN 512A140	
1MP10		BUMPER, RUBBER: Neoprene, black, 5/16 in. dia rounded head; mfr 75543, NP 210-M; (Admiral PN 512D42-9)	
1MP11		GASKET: Neoprene, 1/32 in. thk, 3-1/2 in. square, 25/32 in. radius corners, 3-1/8 in. sq open center; mfr 70117, PN 512B159	
1MP12		BUMPER, RUBBER: Neoprene, black, 3/32 in. thk, 3-3/4 in. square, 15/32 in. radius corners, 5/16 in. w; mfr 70117, PN 512B160	
1MP13		PAD, CUSHIONING: Neoprene, black, 3/16 in. thk; 1-1/2 in. dia; mfr 70117, PN 512A157	
1MP14		RETAINER, TUBE: Aluminum, 0.128 in. thick, "U" shape, 2-7/8 in. w x 5/8 in. h; mfr 70117, PN 515B885	5-28
1MP15		RETAINER, CAPACITOR: 3/4 in. loop, 0.125 in. dia mtg hole; mfr 70117, PN 519B49	
1MP16		SPRING, COIL: One loop; mfr 70117, PN 518A209	
1MP17		SCALE, CRT: Lucite 0.080 in. thk, 3-15/32 in. w x 4 in. lg; mfr 70117, PN 521C18-1	5-28
1MP18		FILTER, CRT: Lucite, 0.060 in. thk, 3-15/32 in. w x 4 in. lg; mfr 70117, PN 521C18-2	5-28
1MP19		BUSHING, SLEEVE: Stainless steel, 3/8 in. od x 0.187 in. id; mfr 70117, PN 527B329-12	
1MP20		SHAFT, FLEXIBLE: Mfr 57711, PN SK6341-C; (Admiral PN GC2404)	5-28
1MP21		COUPLING, SHAFT: Rod, nylon 7/16 in. dia x 5/8 in. lg, holes at both ends 0.260 in. dia, 1/4 in. deep; mfr 70117, PN 527B462	
1MP22		SPACER, SLEEVE: Brass, tubing, 3/16 in. od, 0.122 in. id, 1-17/32 in. lg; mfr 70117, PN 529C3-25-76	
1MP23		KNOB: Black bakelite, 1 in. dia, brass insert, 0.267 in. hole; mfr 70117, PN 533A98-1	5-24
1MP24		KNOB: Black bakelite, 1 in. dia, brass insert, 0.253 in. hole; mfr 70117, PN 533A98-3	5-24
1MP25		KNOB: Black bakelite, mfr 75376, PN 5-645-5L-BB, 538; (Admiral PN 533B99-1)	5-24
1MP26		KNOB: Black bakelite; mfr 75376, PN 5-645-5L-BB; (Admiral PN 533B99-3)	5-24
1MP27		HANDLE, BOW: 3/16 in. dia, "U" shape, 6-32 thd on each end, 1-3/4 in. mtg ctr; mfr 70117, PN 537B70-3	5-28
1MP28		STRAP NUT, SOCKET: Brass, cad plate, cresent, two 4-40 thd holes; mfr 91662, PN 290; (Admiral PN 587B8-16)	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1MP29		RETAINER TUBE: Mfr 07387, PN 2E; (Admiral PN 511D6-1)	5-28
1MP30		CAP, ELECTRICAL: Cup shape, 15/16 in. id, 3/8 in. deep; mfr 70117, PN 533B186-1	5-28
1MP31		RETAINER, CAPACITOR: 5/8 in. loop, 5/32 in. x 1/4 in. mtg hole; mfr 70117, PN 511A60-1	
1MP32		BUMPER, RUBBER: Mfr 70117, PN GB1737	
1P1		Not Used	
1P2		CONNECTOR, PLUG: 24 contacts, two hole mtg, 2-7/8 in. mtg centers; mfr 02660, PN 26-4100-24P; (Admiral PN 588C83-7)	5-27
1P3	See 1TB4	For Reference only	5-27
1R1		RESISTOR, FIXED, FILM: 7 megohm, ±1%, 1/2 watt; mfr 75042, PN type MDC 7 meg ±1%	5-28
1R2		RESISTOR: MIL type RN70B9973F	5-29
1R3		RESISTOR: MIL type RN70B2501F	5-29
1R4 & 1R5		RESISTOR: MIL type RN70B7003F	5-29
1R6		RESISTOR: MIL type RC42GF750J	5-28
1R7		RESISTOR: MIL type RN70B7503F	5-29
1R8		RESISTOR: MIL type RN70B2503F	5-29
1R9		RESISTOR: MIL type RN70B9953F	5-29
1R10		RESISTOR: MIL type RN70B5001F	5-29
1R11		RESISTOR: MIL type RN70B1004F	5-29
1R12		RESISTOR: MIL type RN70B9003F	5-29
1R13		RESISTOR: MIL type RN70B1003F	5-29
1R14		RESISTOR: MIL type RN70B9903F	5-29
1R15		RESISTOR: MIL type RN70B1002F	5-29
1R16		RESISTOR: MIL type RN70B9503F	5-29
1R17		RESISTOR: MIL type RN70B5002F	5-29
1R18		RESISTOR: MIL type RN70B9753F	5-29
1R19		RESISTOR: MIL type RN70B2502F	5-29
1R20		RESISTOR: MIL type RC32GF910J	5-27
1R21 & 1R22		RESISTOR: MIL type RC42GF133J	5-27
1R23		RESISTOR: MIL type RC20GF121J	5-27
1R24 & 1R25		RESISTOR: MIL type RC20GF392J	5-27
1R26 & 1R27		RESISTOR: MIL type RC20GF472J	5-27

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1R28 & 1R29		RESISTOR: MIL type RC32GF133J	5-27
1R30		RESISTOR: MIL type RC20GF225J	5-27
1R31		RESISTOR: MIL type RC20GF101J	5-27
1R32		Same as 1R26	5-27
1R33		Same as 1R31	5-27
1R34		RESISTOR: MIL type RC20GF750J	5-27
1R35		Same as 1R30	5-27
1R36		Same as 1R26	5-27
1R37 & 1R38		RESISTOR: MIL type RC42GF113J	5-28
1R39		RESISTOR: MIL type RC20GF272J	5-27
1R40		RESISTOR: MIL type RV4LAXSA501A	5-28
1R41		RESISTOR, VARIABLE, COMPOSITION: 500 ohms, ±10%, 2 watts; mfr 70117, PN 575D3-83	5-28
1R42		Same as 1R39	5-27
1R43		RESISTOR: MIL type RC20GF512J	5-27
1R44		RESISTOR: MIL type RC20GF155J	5-27
1R45		Same as 1R43	5-27
1R46		RESISTOR: MIL type RC20GF105J	5-27
1R47A-B		RESISTOR, VARIABLE, COMPOSITION: Two shaft, 3 section 750,000 ohm, 100,000 ohm, and 100,000 ohm, ±10%, 2 watts; mfr 70117, PN 575B25	5-27
1R48		Same as 1R46	5-27
1R49		RESISTOR: MIL type RC42GF301J	5-27
1R50		Same as 1R49	5-27
1R51 thru 1R53		RESISTOR: MIL type RC42GF821J	5-27
1R54		RESISTOR: MIL type RC20GF470J	5-27
1R55 thru 1R57		Same as 1R51	5-27
1R58		RESISTOR: MIL type RC20GF154J	5-27
1R59A-B		RESISTOR, VARIABLE: Section one ww 75 ohms, ±10%. 2 watts, section two composition, 100,000 ohms, ±20%, 1/2 watt, two shafts; mfr 70117, PN 575B26	5-27
1R60		RESISTOR: MIL type RC20GF364J	5-27
1R61		Not Used	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1R62 thru 1R64		RESISTOR: MIL type RC20GF102J	5-27
1R65 & 1R66		RESISTOR: MIL type RC07GF473J	
1R67 & 1R68		Same as 1R31	
1R69		Same as 1R62	5-28
1R70		RESISTOR: MIL type RV4LAXSA102A	5-28
1R71		RESISTOR: MIL type RC20GF222J	5-27
1R72		RESISTOR: MIL type RW69G1R0	5-27
1R73		Same as 1R72	5-27
1R74A		RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, ±10%, 1 watt, two shafts; mfr 70117, PN 575B24	5-28
1R74B		RESISTOR, VARIABLE, COMPOSITION: 5 megohms, +10%, 2 watts, mfr 70117, PN 575D3-82	5-28
1R75 thru 1R82		For reference only	
1R83		Same as 1R58	5-27
1R84		RESISTOR: MIL type RC20GF104J	5-30
1R85		Same as 1R44	5-30
1R86		Same as 1R46	5-27
1R87		RESISTOR: MIL type RC20GF684J	5-27
1R88		RESISTOR: MIL type RC20GF103J	5-30
1R89		Not Used	
1R90		RESISTOR: MIL type RC20GF185J	5-28
1R91		Same as 1R90	5-28
1R92		Same as 1R46	5-30
1R93		RESISTOR: MIL type RC20GF562J	5-27
1R94		RESISTOR: MIL type RC20GF112J	5-27
1R95		RESISTOR, FIXED, COMPOSITION: 2.7 ohms, ±5%, 1/4 watt; mfr 01121, PN CB27G5; (Admiral PN 560B28-18)	5-29
1R96		Same as 1R95	5-29
1S1		SWITCH, TOGGLE: Subminiature; mfr 70309, PN TSA-16; (Admiral PN 577B40)	5-28
1S2		SWITCH, ROTARY: Three sections, nine positions, assembly with capacitors and resistors; mfr 70117, PN GD4899	5-28
1T1		TRANSFORMER, RF: Five windings, ten leads; mfr 01961, PN PE2818; (Admiral PN 569C30)	5-28

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
1T2		TRANSFORMER, RF: Two windings, for terminals, assembly; mfr 70117, PN GB4826	5-28
1TB1		TERMINAL BOARD: Plastic 1/16 in. thk, 2-1/2 in. x 3-7/16 in. overall dim, 28 holes; mfr 70117, PN 532B282	5-28
1TB2		TERMINAL BOARD: Triangle, plastic 3/32 in. thk, three terminals; mfr 70117, PN 532B286	5-28
1TB3		TERMINAL BOARD: Plastic 1/8 in. thk, 3-7/32 in. x 4-15/32 in. overall dim, with 16 terminals; mfr 70117, PN 532B298	5-30
1TB4		PRINTED CIRCUIT BOARD: Plastic 1/8 in. thk, 3-5/16 in. x 3-5/8 in. overall dim, with 5 eyelets; mfr 70117, PN GB1581	5-27
1V1 thru 1V4		ELECTRON TUBE: MIL type 5814A	5-28
1V5 & 1V6		ELECTRON TUBE: MIL type 6BQ5	5-28
1V7		ELECTRON TUBE: Mfr 20182, PN 4MP1; (Admiral PN 594C6)	5-28
1V8		Same as 1V1	5-28
1V9 & 1V10		ELECTRON TUBE: MIL type 1V2/USN	5-28
1XV1 thru 1XV6		SOCKET, TUBE: MIL type TS103P01	5-27
1XV7		SOCKET, CRT: Mfr 71785, PN 9470-12; (Admiral PN 587B39)	5-28
1XV8 thru 1XV10		Same as 1XV1	5-27
1XZ1		SOCKET, TUBE: MIL type TS101P02	5-27
1Z1		FILTER ASSEMBLY: Mfr 71436, PN 2348; (Admiral PN 574C39)	5-28
2		SWEEP INTENSITY: Mfr 70117, PN GE2072-6	5-31
2C1		Same as 1C44	5-32
2C2 & 2C3		CAPACITOR: MIL type CM05C100K03	5-31
2C4		CAPACITOR: MIL type CM05D200J03	5-32
2C5		CAPACITOR: MIL type CM05E270J03	5-31
2C6		Same as 2C2	5-31
2C7		Same as 1C33	5-31
2C8		CAPACITOR: MIL type CM05C050K03	5-31
2C9		CAPACITOR, FIXED, MICA: 15 pf, ±5%, 500 vdcw; mfr 72136, PN DM15C150J; (Admiral PN 565C21-44)	5-31

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2C10		CAPACITOR: MIL type CM05E470J03	5-31
2C11		Same as 2C2	5-31
2C12		CAPACITOR, FIXED, MICA: 2 pf, ±0.5 pf, 500 vdcw; mfr 72136, PN DM15C020K; (Admiral PN 565C21-60)	5-31
2C13		CAPACITOR: MIL type CM05F271J03	5-31
2C14		CAPACITOR: MIL type CM06F332J03	5-31
2C15		CAPACITOR: MIL type CP05A1KE333K3	5-31
2C16		CAPACITOR: MIL type CP05A1KF474K3	5-31
2C17		CAPACITOR: MIL type CM05C120K03	5-32
2C18		CAPACITOR: MIL type CM05F101J03	5-31
2C19		CAPACITOR, FIXED, MICA: 470 pf, ±5%, 300 vdcw; mfr 72136, PN DM15F471J; (Admiral PN 565C21-42)	5-32
2C20		CAPACITOR: MIL type CM05F151J03	5-31
2C21		Same as 1C33	5-31
2C22 thru 2C24		Same as 1C44	5-32
2C25		CAPACITOR: MIL type CM05E220J03	5-31
2C26		Same as 1C44	5-31
2C27		Same as 1C27	5-31
2C28		Same as 2C20	5-31
2C29		Same as 1C44	5-31
2C30		Same as 2C25	5-32
2C31		Same as 1C44	5-31
2C32		Same as 2C10	5-32
2C33 & 2C34		Same as 1C44	5-32
2C35		Same as 2C18	5-32
2C36		Same as 1C27	5-32
2C37		CAPACITOR: MIL type CM06F102J03	5-32
2C38		Same as 2C9	5-31
2C39		CAPACITOR: MIL type CM05F181J03	5-32
2C40		CAPACITOR: MIL type CM05E680J03	5-32
2C41		Same as 2C9	5-31
2C42		Same as 1C44	5-32
2C43		Same as 2C40	5-32
2C44		Same as 1C44	5-32
2C45		Same as 2C13	5-32

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2C46		Same as 1C44	5-31
2C47		Same as 2C18	5-31
2C48		Same as 1C44	5-31
2C49		Same as 2C5	5-32
2C50		Same as 2C10	5-32
2C51		Same as 2C13	5-31
2C52 & 2C53		Same as 1C44	5-32
2C54		Same as 2C19	5-31
2CR1		Same as 1CR1	5-32
2CR2 & 2CR3		SEMICONDUCTOR DIODE: MIL type 1N277	5-32
2CR4		SEMICONDUCTOR DIODE: Mfr 04713, PN 1N979B	5-32
2CR5		SEMICONDUCTOR DIODE: MIL type 1N459	5-32
2CR6		SEMICONDUCTOR DIODE: MIL type 1N643	5-32
2CR7		Same as 2CR2	5-31
2CR8		Same as 1CR1	5-31
2CR9 & 2CR10		Same as 2CR2	5-31
2CR11 & 2CR12		Same as 1CR1	5-31
2E1		Same as 1E1	5-31
2E2		Same as 1E2	5-31
2E3		SHIELD, TUBE: MIL type TS102U01	5-31
2E4		Same as 1E11	5-31
2E5		Same as 1E8	5-31
2E6		Same as 1E3	5-31
2E7		TERMINAL, STUD: Teflon insulation; mfr 98291, PN RST-SM-31TUR; (Admiral PN 510B3-18)	5-32
2E8		OVEN, TUNED, CIRCUIT: 1.292 in. dia, 3-23/64 in. h, 8 pin plug at one end, heater 117 vac, 10 watts; mfr 70117, PN 574D58	5-31
2J1		Not Used	
2J2		CONTACT ASSEMBLY: Mfr 70117, PN GB2107	5-32
2J3 thru 2J5		JACK, TIP: Mfr 98291, PN SKT-2BC; (Admiral PN 586C10-16)	5-31

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2L1		COIL, RF: Single pl universal winding, axial leads, 500 μh; mfr 70117, PN 573B11-40	5-32
2L2		TRANSFORMER, RF: Tuning range 950 kc to 1050 kc; mfr 99800, PN ESO No. 704; (Admiral PN 569B37)	5-31
2L3		COIL, RF: MIL type MS75008-39	5-32
2L4		COIL, RF: MIL type MS91189-29	5-31
2MP1		CLAMP, LOOP: Mfr 71617, PN CPC-1953-3B; (Admiral PN 511D7-35)	5-31
2MP2		Same as 1MP4	
2MP3		STRAP NUT, SOCKET: Two holes 4-40 tap, 1-1/8 in. mtg ctr; mfr 91662, PN288; (Admiral PN 587B8-15)	5-32
2MP4		HANDLE, BOW: 3/16 in. dia, "U" shape, 6-32 thd at each end, 1-3/4 in. mtg ctr; mfr 70117, PN 537B70-1	5-32
2MP5		Same as 1MP19	
2MP6		CLAMP, LOOP: Mfr 95987, PN WC 13/16-6; (Admiral PN 511D7-59)	
2MP7		Same as 1MP24	5-24
2MP8		Same as 1MP26	5-24
2MP9		Same as 1MP28	5-32
2MP10		MOUNTING, SPRING: Aluminum 1-3/8 in. w, 3-5/16 in. lg, with 13/16 in. x 2-1/2 in. cut out; mfr 70117, PN 515C1093	5-32
2MP11		CLAMP, LOOP: Mfr 95987, PN WC 1-1/4-6; (Admiral PN 511D7-37)	5-31
2P1		Same as 1P2	5-31
2R1		RESISTOR: MIL type RC20GF272K	5-32
2R2		RESISTOR: MIL type RC20GF101K	5-32
2R3 & 2R4		Same as 1R58	5-31
2R5		RESISTOR: MIL type RC42GF333J	5-32
2R6		Same as 2R5	5-32
2R7 & 2R8		Same as 1R58	5-31 5-32
2R9		RESISTOR: MIL type RC20GF473K	5-31
2R10		RESISTOR: MIL type RC20GF393J	5-32
2R11		RESISTOR: MIL type RC20GF474J	5-32
2R12		RESISTOR: MIL type RC20GF622J	5-32
2R13		RESISTOR: MIL type RC20GF563J	5-32
2R14		RESISTOR: MIL type RC42GF104K	5-31
2R15		RESISTOR: MIL type RC20GF103K	5-31
2R16		RESISTOR: MIL type RC20GF823J	5-32
2R17		RESISTOR: MIL type RC20GF333J	5-32

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2R18		Same as 2R14	5-32
2R19		Same as 1R21	5-32
2R20		Same as 2R14	5-32
2R21		RESISTOR: MIL type RC42GF222J	5-31
2R22		Same as 2R14	5-31
2R23		RESISTOR: MIL type RC20GF753J	5-32
2R24		Same as 2R13	5-32
2R25		RESISTOR: MIL type RC32GF682J	5-31
2R26		RESISTOR: MIL type RC20GF132J	5-32
2R27		RESISTOR: MIL type RC32GF562J	5-32
2R28		RESISTOR: MIL type RC32GF434J	5-32
2R29A-B		RESISTOR, VARIABLE: Composition, Tandem, 5 megohms, +20% -0%, 350,000 ohms; ±10%; mfr 70117, PN 575C4-7	5-31
2R30		RESISTOR: MIL type RC42GF184J	5-31
2R31		RESISTOR: MIL type RC20GF106J	5-32
2R32		RESISTOR: MIL type RC20GF183J	5-32
2R33		RESISTOR, VARIABLE: MIL type RV2LAYSA502A	5-31
2R34		RESISTOR: MIL type RC42GF153J	5-32
2R35		RESISTOR: MIL type RC42GF393J	5-31
2R36		Same as 2R35	5-31
2R37		Same as 1R71	5-32
2R38		RESISTOR: MIL type RC42GF752J	5-31
2R39		Same as 2R35	5-31
2R40		RESISTOR: MIL type RC42GF473J	5-32
2R41		RESISTOR: MIL type RC20GF125J	5-32
2R42		Same as 1R87	5-32
2R43		Same as 2R1	5-31
2R44		Same as 2R2	5-31
2R45		RESISTOR: MIL type RC20GF271J	5-31
2R46		Same as 1R44	5-32
2R47		Same as 2R41	5-32
2R48		RESISTOR: MIL type RC42GF223J	5-32
2R49		Same as 1R62	5-32
2R50		RESISTOR, VARIABLE: MIL type RV2LAYSA102A	5-31
2R51		RESISTOR: MIL type RC20GF471J	5-31
2R52		RESISTOR: MIL type RC32GF681J	5-31
2R53		RESISTOR: MIL type RC20GF104K	5-32

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2R54		Same as 1R62	5-32
2R55		RESISTOR: MIL type RC32GF563J	5-32
2R56		RESISTOR: MIL type RC20GF334K	5-32
2R57		RESISTOR: MIL type RC20GF221J	5-32
2R58		RESISTOR: MIL type RC42GF682J	5-32
2R59		RESISTOR: MIL type RC20GF332J	5-32
2R60		Same as 2R15	5-32
2R61		Same as 2R10	5-32
2R62		RESISTOR: MIL type RC20GF623J	5-32
2R63		RESISTOR: MIL type RC32GF153J	5-32
2R64		Same as 2R51	5-32
2R65		RESISTOR: MIL type RC20GF470K	5-31
2R66		Same as 1R88	5-32
2R67		RESISTOR: MIL type RC20GF182J	5-31
2R68		RESISTOR: MIL type RC20GF181J	5-32
2R69		Same as 2R51	5-32
2R70		RESISTOR: MIL type RC42GF273J	5-32
2R71		Same as 2R55	5-32
2R72		Same as 2R51	5-32
2R73		Same as 2R33	5-31
2R74		RESISTOR: MIL type RC20GF153J	5-32
2R75		Same as 1R93	5-32
2R76		Same as 1R58	5-32
2R77		RESISTOR: MIL type RC20GF151J	5-31
2R78		Same as 2R2	5-31
2R79		RESISTOR: MIL type RC20GF822J	5-31
2R80		Same as 2R79	5-32
2R81		Same as 2R55	5-32
2R82		Same as 1R93	5-32
2R83		RESISTOR: MIL type RC20GF680J	5-32
2R84		Same as 2R2	5-32
2R85		Same as 2R10	5-32
2R86		RESISTOR: MIL type RV2LAYSA253A	5-31
2R87		Same as 1R88	5-32
2R88		Same as 1R84	5-32
2R89		Same as 2R75	5-32
2R90		Same as 2R83	5-32

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2R91		Same as 1R23	5-31
2R92		Same as 2R2	5-31
2R93		RESISTOR: MIL type RC20GF203J	5-31
2R94		Same as 2R53	5-32
2R95		RESISTOR: MIL type RV4NAYSB253A	5-31
2R96		Same as 1R39	5-31
2R97		Same as 1R84	5-31
2R98 & 2R99		Same as 2R5	5-31
2R100		Same as 2R48	5-31
2R101		RESISTOR: MIL type RC20GF243J	5-32
2R102		Same as 2R23	5-32
2R103		Same as 2R45	5-31
2R104		Same as 1R39	5-31
2R105		RESISTOR: MIL type RC20GF682J	5-32
2R106		Same as 1R71	5-32
2R107		RESISTOR: MIL type RC20GF334J	5-32
2R108		Same as 2R17	5-32
2S1		SWITCH, TOGGLE: MIL type MS35059-26	5-31
2S2		SWITCH, TOGGLE: MIL type MS35058-23	5-31
2S3		SWITCH, ROTARY: Single section, five positions; mfr 76854, PN 102651-F1; (Admiral PN 576B83)	5-31
2S4		Same as 2S1	5-31
2S5		Not Used	
2S6		SWITCH, ROTARY: Single section, six positions; mfr 76854, PN 194777-F1; (Admiral PN 576B44)	5-31
2T1		TRANSFORMER, PULSE: Primary and secondary dc resistance, 15 ohms, pulse width, 5 μsec, rise time 0.15 μsec; mfr 01961, PN PE2419; (Admiral PN 574C35-2)	5-32
2T2		TRANSFORMRR, PULSE: Primary and secondary dc resistance, 0.4 ohms, pulse width, 0.15 μsec, rise time 0.08 μsec; mfr 01961, PN PE2414; (Admiral PN 574C34)	5-32
2T3		TRANSFORMER, RF: Iron core tune, 0.1 μsec marker; mfr 70117, PN 572C13	5-31
2T4 thru 2T6		TRANSFORMER, PULSE: Primary dc resistance, 1.2 ohms secondary dc resistance, 1.3 ohms, pulse width, 1.0 μsec, rise time, 0.05 μsec; mfr 01961, PN PE2415; (Admiral PN 574C34-2)	5-32
2T7		Same as 2T2	5-32
2V1 & 2V2		Same as 1V1	5-31

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
2V3		ELECTRON TUBE: MIL type 5687WA	5-31
2V4		Same as 1V1	5-31
2V5		ELECTRON TUBE: MIL type 5726/6AL5W	5-31
2V6		Same as 2V3	5-31
2V7 & 2V8		Same as 1V1	5-31
2V9 & 2V10		ELECTRON TUBE: Mfr 33173, PN 6U8A	5-31
2V11		ELECTRON TUBE: MIL type 12AT7WA	5-31
2XV1 thru 2XV4		Same as 1XV1	5-32
2XV5		SOCKET, TUBE: MIL type TS102P01	5-32
2XV6 thru 2XV11		Same as 1XV1	5-32
2XZ1		Same as 1XZ1	5-31
2Z1		OSCILLATOR, NETWORK: Transformer RF assembly; mfr 70117, PN GC1932-2	5-31
3		XTAL MARK UNIT: Mfr 70117, PN GE2057-6	5-33
3A1 & 3A2		DIAL, SCALE: Black background with white characters, 1 to 10 spaced 30^{O} around the dial, gear on other side; mfr 70117, PN GB1606	5-24
3A3 & 3A4		BASIC, DELAY LINE: Variable vernier; mfr 70117, PN GC1949	5-33
3C1		CAPACITOR: MIL type CM06F471J03	5-34
3C2		Same as 1C27	5-34
3C3		Same as 2C10	5-34
3C4		CAPACITOR, FIXED, PAPER: 0.01 μf, $\pm$20%, 400 vdcw; mfr 00656, PN P8292ZN.01UF400V; (Admiral PN 565D45-10)	5-33
3C5		Same as 2C13	5-34
3C6		Same as 2C2	5-34
3C7		CAPACITOR: MIL type CM05E820J03	5-34
3C8		CAPACITOR, FIXED, PAPER: 0.01 μf, $\pm$20%, 200 vdcw; mfr 00656, PN P8292ZN.01UF200V; (Admiral PN 565D45-1)	5-33
3C9		Same as 2C5	5-34
3C10		Same as 3C8	5-33

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3C11		Same as 1C41	5-33
3C12		Same as 2C18	5-34
3C13		Same as 2C10	5-34
3C14		Same as 3C8	5-34
3C15		Not Used	
3C16		CAPACITOR: MIL type CM05F121J03	5-34
3C17		Same as 3C4	5-33
3C18		Same as 3C16	5-34
3C19		CAPACITOR, FIXED, PAPER: 0.05 μf, ±20%, 200 vdcw; mfr 00656, PN P8292ZN.05UF200V; (Admiral PN 565D45-4)	5-33
3C20		Same as 2C8	5-34
3C21		CAPACITOR: MIL type CM07F153J03	5-33
3C22 & 3C23		Same as 3C8	5-34 5-33
3C24		Same as 2C37	5-34
3C25		Same as 1C33	5-33
3C26		CAPACITOR: MIL type CE13C100N	5-33
3C27		Same as 3C8	5-33
3C28		Same as 1C27	5-34
3C29		Same as 1C7	5-34
3C30		Same as 1C49	5-34
3C31		CAPACITOR: MIL type CM06F302J03	5-33
3C32 & 3C33		Same as 2C19	5-34
3C34		Same as 2C13	5-33
3C35		Same as 3C7	5-34
3C36		Same as 2C39	5-34
3C37		Same as 3C19	5-34
3C38		Same as 3C26	5-33
3C39		Same as 1C35	5-33
3C40		Same as 1C7	5-33
3C41		Same as 3C31	5-33
3C42		Same as 2C19	5-34
3C43		Same as 2C13	5-33
3C44		Same as 1C34	5-33
3C45		Same as 2C5	5-33
3C46		Same as 2C10	5-34

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3C47		Same as 3C16	5-34
3C48		Same as 3C26	5-33
3C49		Same as 1C35	5-33
3C50		Same as 3C19	5-34
3C51		Same as 1C48	5-33
3C52		Same as 1C49	5-33
3C53		Same as 2C19	5-34
3C54 thru 3C57		Same as 1C44	5-34
3C58		Same as 1C34	5-34
3C59		Same as 2C5	5-34
3C60		Same as 2C25	5-34
3C61 & 3C62		Same as 1C27	5-34
3C63 & 3C64		Same as 2C19	5-34
3C65 & 3C66		Same as 2C10	5-34
3CR1 & 3CR2		Same as 1CR1	5-34
3CR3		Not Used	
3CR4		Not Used	
3CR5 thru 3CR8		Same as 1CR1	5-34
3CR9		Same as 2CR6	5-34
3CR10 thru 3CR12		Same as 1CR1	5-34
3CR13		Not Used	
3CR14		Same as 2CR6	5-34
3CR15		Same as 1CR1	5-34
3DL1		DELAY LINE: 0.438 in. dia, 4-13/16 in. lg, 0.6 μsec time delay; mfr 70117, PN 572D11-8	5-33
3DL2 & 3DL3		DELAY LINE: 0.438 in. dia, 9-3/8 in. lg, 11.25 μsec time delay; mfr 70117, PN 572D11-2	5-33
3E1		Same as 1E1	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3E2		Same as 1E2	
3E3		Same as 1E3	
3E4		Same as 2E7	
3E5		Same as 1E8	5-33
3E6		SHIELD, TUBE: MIL type TS102U02	5-33
3E7		SHIELD, TUBE: MIL type TS103U01	5-33
3E8		Same as 1E11	
3H1		SCREW, MACHINE: 4-40 x 5/16 in. thd, head 0.153 in. dia x 0.09 in. lg; mfr 70117, PN 501D42-6	
3H2		Same as 1H1	
3J1 thru 3J4		Same as 1J1	5-33
3J5		Not Used	
3J6 & 3J7		Same as 2J3	5-34
3L1		Not Used	
3L2		COIL, RF: Single pi universal winding, axial leads, 2500 μh; mfr 70117, PN 573B11-46	5-34
3L3		COIL, PICKUP, DL: Single pi universal winding 1.9 mh; mfr 70117, PN 569C32-3	5-34
3L4		Same as 3L2	5-34
3L5		Same as 3L3	5-34
3MP1		BEARING, HELIX: Hard rubber, 1-3/8 in. od x 0.453 in. id; mfr 70117, PN 512A152	
3MP2		CLAMP, LOOP: Mfr 71616, PN CPC-1953-7B; (Admiral PN 511D7-32)	5-33
3MP3		BOBBIN, SLEEVE: Hard rubber, 15/16 in. od and 0.512 in. id; mfr 70117, PN 512A150	5-33
3MP4		PINION, SHAFT: 3/16 in. dia x 1-1/2 in. lg shaft with gear; mfr 70117, PN 528A83	
3MP5		CLIP, SPRING: 5/8 in. dia; mfr 80033, PN 500-625; (Admiral PN 518C20-3)	
3MP6		CLIP, SPRING: 3/8 in. x 3/8 in. x 15/64 in. h; mfr 70117, PN 518A104-2)	
3MP7		SPRING, COIL: Single turn 21/32 in. id; mfr 70117, PN 519C12-38	
3MP8		Same as 1MP19	
3MP9		SPACER, SLEEVE: 0.187 in. od, 0.120 in. id, 0.220 in. lg; mfr 70117, PN 529C3-15-92	
3MP10		GEAR, SPUR: 18 teeth; mfr 70117, PN 530B59-5	5-24
3MP11		Same as 1MP24	5-24
3MP12		Same as 1MP26	
3MP13		KNOB: Black bakelite; 13/16 in. dia; 1 in. dia skirt; mfr 75376, PN S-647-4L-BB; (Admiral PN 533B99-5)	5-24

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3MP14		Same as 2MP4	5-24
3MP15		Same as 2MP3	5-24
3MP16		Same as 1MP28	5-24
3MP17		KNOB: Black bakelite; 13/16 in. dia, 1 in. dia skirt; mfr 75376, PN S-647-3L-BB; (Admiral PN 533B99-4)	
3P1 thru 3P3		Not Used	
3P4		Same as 1P2	5-33
3R1		Same as 2R53	5-34
3R2		Same as 2R9	5-34
3R3		RESISTOR: MIL type RC32GF473K	5-34
3R4		RESISTOR: MIL type RC20GF392K	5-33
3R5		RESISTOR: MIL type RC20GF105K	5-34
3R6		Same as 1R94	5-33
3R7		Same as 1R39	5-34
3R8		RESISTOR: MIL type RC20GF122J	5-34
3R9		RESISTOR: MIL type RC32GF183J	5-34
3R10		RESISTOR: MIL type RC32GF222K	5-33
3R11		Same as 2R21	5-34
3R12		Same as 2R51	5-34
3R13		Same as 2R68	5-34
3R14		RESISTOR: MIL type RC20GF472K	5-34
3R15		Same as 1R58	5-34
3R16		Same as 2R15	5-34
3R17		RESISTOR: MIL type RC20GF683K	5-34
3R18		RESISTOR: MIL type RC20GF273K	5-34
3R19		Not Used	
3R20		Same as 1R58	5-34
3R21		Not Used	
3R22		Same as 3R9	5-34
3R23		Same as 3R10	5-34
3R24		Same as 3R9	5-34
3R25		RESISTOR: MIL type RC20GF391K	5-34
3R26		RESISTOR: MIL type RC32GF154J	5-34
3R27		Same as 1R58	5-34
3R28		Same as 2R51	5-34
3R29		RESISTOR: MIL type RC20GF184J	5-34

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3R30		Same as 2R74	5-34
3R31		RESISTOR: MIL type RC20GF271K	5-34
3R32		RESISTOR: MIL type RC20GF821J	5-34
3R33		Same as 2R68	5-34
3R34		RESISTOR: MIL type RC20GF270K	5-34
3R35		RESISTOR: MIL type RC20GF560K	5-34
3R36		Same as 2R15	5-34
3R37		Same as 1R88	5-33
3R38A-B		RESISTOR, VARIABLE: Composition, Dual, 5000 ohms, ±10%, 1 watt and 6.5 megohms, ±15%, 1 watt; mfr 70117, PN 575C9-3	5-33
3R39		Same as 2R105	5-33
3R40		RESISTOR: MIL type RV5LAYSB503A	5-33
3R41		RESISTOR: MIL type RC20GF474K	5-33
3R42		RESISTOR: MIL type RC32GF124K	5-34
3R43		Same as 3R5	5-34
3R44		Same as 3R14	5-34
3R45		Same as 2R45	5-34
3R46		Same as 1R88	5-33
3R47		RESISTOR: MIL type RC32GF393J	5-34
3R48		Same as 1R26	5-34
3R49		RESISTOR: MIL type RC20GF331K	5-34
3R50		Same as 2R51	5-34
3R51 & 3R52		Same as 3R34	5-34 5-33
3R53		RESISTOR: MIL type RC20GF181K	5-34
3R54		Same as 3R9	5-33
3R55		RESISTOR: MIL type RC20GF202J	5-34
3R56		Same as 1R84	5-34
3R57		RESISTOR: MIL type RC42GF563J	5-34
3R58		RESISTOR: MIL type RC32GF334J	5-34
3R59		Same as 2R2	5-34
3R60 & 3R61		Not Used	
3R62		RESISTOR: MIL type RC42GF472K	5-33
3R63		Same as 3R25	5-34
3R64		RESISTOR: MIL type RV4NAYSB501A	5-33

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3R65		RESISTOR: MIL type RC42GF514J	5-34
3R66		Same as 1R46	5-34
3R67		RESISTOR: MIL type RC32GF244J	5-34
3R68		Same as 2R2	5-34
3R69 thru 3R71		Not Used	
3R72		RESISTOR: MIL type RV4NAYSB103A	5-34
3R73		Same as 2R77	5-34
3R74		Not Used	
3R75		RESISTOR: MIL type RC42GF362J	5-34
3R76		RESISTOR: MIL type RC32GF123J	5-33
3R77		RESISTOR: MIL type RC20GF363J	5-34
3R78		RESISTOR: MIL type RC20GF114J	5-34
3R79		RESISTOR: MIL type RC42GF912J	5-34
3R80		Same as 3R7	5-34
3R81		RESISTOR: MIL type RC20GF821K	5-33
3R82		Same as 2R2	5-33
3R83		Same as 3R18	5-34
3R84		RESISTOR: MIL type RC20GF751J	5-34
3R85		Same as 3R67	5-34
3R86		Not Used	
3R87		RESISTOR: MIL type RC20GF471K	5-34
3R88		RESISTOR: MIL type RC32GF112J	5-34
3R89		Same as 1R88	5-33
3R90		RESISTOR: MIL type RC32GF683J	5-34
3R91		Same as 2R105	5-34
3R92		Same as 3R88	5-34
3R93		Same as 3R65	5-34
3R94		Same as 3R67	5-34
3R95		Same as 1R46	5-34
3R96		Same as 2R2	5-34
3R97 thru 3R99		Not Used	
3R100		Same as 3R72	5-34
3R101		Same as 3R49	5-34
3R102		Not Used	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3R103		Same as 3R75	5-34
3R104		Same as 3R76	5-33
3R105		Same as 3R77	5-34
3R106		Same as 3R78	5-34
3R107		Same as 3R79	5-34
3R108		Same as 3R7	5-34
3R109		Same as 3R81	5-33
3R110		Same as 2R2	5-33
3R111		Same as 3R18	5-34
3R112		Same as 3R84	5-34
3R113		Not Used	
3R114		Same as 1R88	5-33
3R115		Same as 3R63	5-34
3R116		Same as 3R90	5-34
3R117		Same as 2R105	5-34
3R118 & 3R119		Same as 3R49	5-34
3R120		Same as 3R53	5-34
3S1		SWITCH, ROTARY: Two sections, five positions; mfr 81716, PN 94775-F2; (Admiral PN 576B47)	5-34
3S2		SWITCH, ROTARY: Two sections, four positions; mfr 76854, PN 194774-F2; (Admiral PN 576B45)	5-34
3S3		SWITCH, ROTARY: Two sections, six positions; mfr 81716; PN 94773-F2; (Admiral PN 576B46)	5-34
3T1		TRANSFORMER, PULSE: Primary and secondary dc resistance, 1 ohm, pulse width 0.5 μsec, rise time 0.06 μsec; mfr 01961, PN PE2411; (Admiral PN 574C34-4)	5-34
3T2		TRANSFORMER, PULSE: Primary and secondary dc resistance, 0.2 ohms, pulse width 0.1 μsec, rise time 0.02 μsec; mfr 01961, PN PE2413; (Admiral PN 574C34-3)	5-34
3T3		Same as 2T1	5-34
3T4 thru 3T6		TRANSFORMER, PULSE: Primary dc resistance, 12 ohms, secondary dc resistance 12.5 ohms, pulse width 2 μsec, rise time 0.1 μsec; mfr 01961, PN PE2416; (Admiral PN 574C31-1)	5-34
3V1		ELECTRON TUBE: MIL type 6AU6WB	5-33
3V2		Same as 2V3	5-33
3V3		Same as 2V11	5-33
3V4 & 3V5		Same as 1V1	5-33

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
3V6		ELECTRON TUBE: MIL type 5670	5-33
3V7		Same as 2V3	5-33
3V8		Same as 2V11	5-33
3V9		Same as 1V1	5-33
3V10		Same as 2V11	5-33
3V11		Same as 3V6	5-33
3V12		Same as 1V1	5-33
3XV1		Same as 2XV5	5-33
3XV2 thru 3XV12		Same as 1XV1	5-33
3XY1 & 3XY2		SOCKET, CRYSTAL: MIL type TS0205C01	5-34
3Y1		CRYSTAL, QUARTZ: MIL type CR-18/U-1KC	5-33
3Y2		CRYSTAL, QUARTZ: 689.655 KC; mfr 70117, PN 593A26	5-33
3Z1 & 3Z2		DELAY LINE: Variable assembly, delay time is from .1 μsec to 11 μsec; mfr 70117, PN GC1664	5-33
4		SIF, CODER UNIT: Mfr 70117, PN GJ4873	5-35
4A1		DELAY LINE ASSEMBLY: Basic, delay line drive; mfr 70117, PN GC1655	5-36
4C1		Same as 2C14	5-36
4C2		Same as 1C33	5-36
4C3		CAPACITOR, FIXED, PAPER: 0.005 μf, ±20%, 400 vdcw; mfr 00656, PN P8292ZN.005UF400V; (Admiral PN 565D45-29)	5-35
4C4		Same as 2C40	5-35
4C5		CAPACITOR: MIL type CM06F511J03	5-37
4C6		CAPACITOR, FIXED, PAPER: 0.25 μf, ±20%, 200 vdcw; mfr 00656, PM P8292ZN.25UF200V; (Admiral PN 565D45-6)	5-35
4C7		Same as 4C5	5-35
4C8		Same as 3C8	
4C9		CAPACITOR: MIL type CM05F391J03	5-35
4C10		Same as 2C9	5-38
4C11		CAPACITOR: MIL type CL65CJ100KP3	5-36
4C12		Same as 1C48	5-36
4C13		Not Used	
4C14		Same as 2C10	5-35
4C15		Same as 2C9	5-34

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4C16		CAPACITOR: MIL type CL35BB300MP3	5-38
4C17		Same as 2C10	5-36
4C18		Same as 4C9	5-38
4C19		CAPACITOR, FIXED, MICA: 820 pf, ±5%, 300 vdcw; mfr 72136, PN DM15F821J; (Admiral PN 565C21-90)	5-35
4C20		Same as 2C25	5-38
4C21		Same as 3C8	5-38
4C22		Same as 4C6	5-38
4C23		Same as 1C35	5-36
4C24		CAPACITOR: MIL type CM06F821J03	5-38
4C25		Same as 1C41	5-38
4C26		Same as 1C35	5-36
4C27		CAPACITOR, FIXED, PLASTIC: 4 μf, ±20%, 300 vdcw; mfr 93110, PN D2Q3405; (Admiral PN 565C39-1)	5-36
4C28		Same as 4C16	5-35
4C29		Same as 3C4	5-35
4C30		Same as 1C33	5-34
4C31 thru 4C34		Same as 1C44	5-38
4CR1 thru 4CR7		Same as 1CR1	5-35 5-36 5-38
4CR8 & 4CR9		SEMICONDUCTOR DIODE: MIL type 1N281	5-38
4CR10 thru 4CR12		Same as 1CR1	5-38
4CR13 & 4CR14		Same as 4CR8	5-38
4CR15 thru 4CR17		Same as 1CR1	5-38
4CR18		Same as 4CR8	5-38
4CR19		Same as 2CR2	5-38
4CR20 thru 4CR35		Same as 4CR8	5-38
4CR36		Same as 1CR1	5-38
4CR37		Same as 4CR8	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4DL1		DELAY LINE: .438 in. dia, 6-5/32 in. lg, 4 μsec time delay; mfr 70117, PN 572D11-3	5-36
4DL2		DELAY LINE: .438 in. dia, 7 in. lg, 2 μsec time delay; mfr 70117, PN 572D11-6	5-38
4DL3 thru 4DL7		DELAY LINE: .438 in. dia, 8-3/8 in. lg, 5.8 μsec time delay; mfr 70117, PN 572D11-5	5-38
4DS1 thru 4DS14		LAMP, GLOW: 105 volt to 125 volt, 1/25 watt, T-2 bulb clear; mfr 24455, PN NE-2A; (Admiral PN 581B1-4)	5-36
4E1		Same as 1E1	
4E2		Same as 1E2	
4E3		Same as 1E3	
4E4		Same as 2E7	
4E5		TERMINAL, STRIP: 1/4 in. w, 7-5/16 in. lg, brass strip with 14 lugs; mfr 70117, PN 515B880	
4E6		Same as 1E8	
4E7		Same as 3E6	
4E8		Same as 3E7	
4E9		Same as 1E11	
4E10		Same as 1E1	
4E11		Same as 1E2	
4H1		NUT, KNURLED: 3/8 in. dia x 1/4 in., 4-40 thd; mfr 70117, PN 502A41-11-3	
4H2		RING, DETENT: 0.108 in. thk, 1 in. od x 0.810 in. id; mfr 70117, PN 527A480	
4J1 thru 4J3		Same as 1J1	5-36
4J4		Not Used	
4J5 thru 4J8		Same as 2J3	5-38
4L1		COIL, RF: Single pi universal winding, 75 μh, axial leads; mfr 70117, 573B11-36	5-36
4L2		COIL, RF: Single pi universal winding, 55 μh, axial leads; mfr 70117, PN 573B11-35	5-37
4L3		Same as 4L2	5-37
4L4 thru 4L6		COIL, RF: Single pi universal winding, 15 μh, axial leads; mfr 70117, PN 573B11-31	5-38
4L7		COIL, RF: Single pi universal winding, 100 μh, axial leads; mfr 70117, PN 573B11-37	5-37

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4L8		COIL, RF: Single pi universal winding, 35 μh, axial leads; mfr 70117, PN 573B11-32	5-37
4L9		Same as 4L1	5-37
4L10 & 4L11		COIL, RF: Delay line pick-up, winding on bobbin assembly, 42 μh; mfr 70117, PN 569C29-7	5-35
4L12 thru 4L16		COIL, RF: Delay line pick-up, winding on bobbin assembly, 75 μh; mfr 70117, PN 569C29-3	5-35
4L17 thru 4L20		COIL, RF: Delay line pick-up, winding on bobbin assembly, 104 μh; mfr 70117, PN 569C29-4	5-35
4L21 thru 4L23		COIL, RF: Delay line pick-up, winding on bobbin assembly, 165 μh; mfr 70117, PN 569C29-1	5-35
4L24 thru 4L26		COIL, RF: Delay line pick-up, winding on bobbin assembly, 240 μh; mfr 70117, PN 569C29-5	5-35
4L27		COIL, DELAY LINE: Single pi universal winding, 110 μh; mfr 70117, PN 569C32-1	5-36
4L28		Same as 2L1	5-38
4MP1		Same as 3MP1	
4MP2		CLAMP, LOOP: Mfr 71616, PN CPC-1953-4B; (Admiral PN 511D7-29)	5-38
4MP3		CLAMP, LOOP: Mfr 71616, PN CPC-1953-5B; (Admiral PN 511D7-30)	5-38
4MP4		RETAINER, TUBE: Mfr 07387, PN 2D-2; (Admiral PN 511D46-2)	5-36
4MP5		CLAMP, LOOP: Mfr 95987, PN WC 7/16 4NA; (Admiral PN 511D7-71)	5-38
4MP6		Same as 1MP24	5-24
4MP7		Same as 3MP3	5-38
4MP8		SPRING, COIL: Single loop 21/32 in. dia; mfr 70117, PN 519C12-36	5-38
4MP9		SPRING, HELICAL: 4-1/2 turns, music wire, 11/64 in. lg; mfr 70117, PN 519C12-37	
4MP10		DIAL, CONTROL: Black plastic, 1 in. dia, white characters 0 to 7, left hand branding; mfr 70117, PN 533C260-1	5-24
4MP11		DIAL, CONTROL: Black plastic, 1 in. dia, white characters 0 to 7, right hand branding; mfr 70117, PN 533C260-2	5-24
4MP12		DIAL, CONTROL: Black plastic, 1-7/8 in. dia, white characters 0 to 7, left hand branding; mfr 70117, PN 533C261-1	5-24
4MP13		DIAL, CONTROL: Black plastic, 1-7/8 in. dia, white characters 0 to 7, right hand branding; mfr 70117, PN 533C261-2	5-24
4MP14		Same as 1MP19	
4MP15		BUSHING, SLEEVE: 7/8 in. dia, 9/16 in. lg; 19/64 in. hole thru center; mfr 70117, PN 527A481	
4MP16		SPACER, SLEEVE: 1/2 in. od, 5/16 in. id, 3/4 in. lg; mfr 70117, PN 529D4-56	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4MP17		BALL, BEARING: Stainless steel, 0.094 in. dia; mfr 70117, PN 530B5-8	
4MP18		CLAMP, CLINCH: 1/4 in. thk, 27/32 in. w, 27/32 in. h, with a 7/16 in. hole; mfr 70117, PN 533B87	
4MP19		KNOB: Black bakelite, 1-5/8 in. dia knob, with 2 in. dia skirt; mfr 75376, PN S-649-3L-BB; (Admiral PN 533A97)	5-24
4MP20		Same as 3MP17	5-24
4MP21		MOUNT, ELECTRIC: Black plastic, 2-3/4 in. dia, 3/4 in. w; mfr 70117, PN 533C102	
4MP22		KNOB: Metal, 1-1/4 in. dia, 55/64 in. w, straight knurl on surface; mfr 70117, PN 533B106	5-24
4MP23		Same as 2MP4	5-24
4MP24		Same as 2MP3	5-38
4MP25		Same as 1MP28	5-38
4MP26		BEARING, BUTTON: Plastic, 0.025 in. thk, 3/8 in. dia; mfr 70117, PN 533A115	
4MP27		Same as 1MP26	5-24
4P1 thru 4P3		Not Used	
4P4		Same as 1P2	
4R1		RESISTOR: MIL type RC32GF134J	5-35
4R2		Same as 2R2	5-38
4R3		Same as 2R14	5-35
4R4		RESISTOR: MIL type RC20GF102K	5-38
4R5		Same as 3R49	5-38
4R6		RESISTOR: MIL type RC42GF202J	5-36
4R7		Not Used	
4R8 & 4R9		Same as 2R53	5-38
4R10		RESISTOR: MIL type RC42GF823K	5-38
4R11		RESISTOR: MIL type RC20GF222K	5-38
4R12		Same as 4R4	5-38
4R13		Same as 2R15	5-38
4R14		RESISTOR: MIL type RC20GF333K	5-38
4R15		Same as 3R53	5-38
4R16 & 4R17		RESISTOR: MIL type RC20GF100K	5-38
4R18		Same as 3R81	5-38

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4R19		Same as 4R16	5-38
4R20		Same as 2R15	5-36
4R21		Same as 2R2	5-38
4R22		RESISTOR: MIL type RC20GF122K	5-35
4R23		Same as 2R15	5-35
4R24		Same as 3R14	5-38
4R25		RESISTOR: MIL type RC20GF682K	5-36
4R26		RESISTOR: MIL type RC32GF272K	5-35
4R27		Same as 2R15	5-35
4R28		RESISTOR: MIL type RC20GF562K	5-36
4R29		RESISTOR: MIL type RC20GF684K	5-35
4R30		Same as 3R10	5-35
4R31		Same as 3R14	5-36
4R32		RESISTOR: MIL type RV2LAYSA101A	5-36
4R33		Same as 3R31	5-35
4R34		Same as 3R4	5-36
4R35		RESISTOR: MIL type RC20GF561K	5-38
4R36		RESISTOR: MIL type RN70B6000F	5-36
4R37		Same as 4R11	5-36
4R38		Same as 4R29	5-38
4R39		RESISTOR: MIL type RC42GF153K	5-36
4R40		RESISTOR: MIL type RC42GF103K	5-38
4R41		RESISTOR: MIL type RC20GF331J	5-38
4R42		Same as 3R14	5-36
4R43		RESISTOR: MIL type RC20GF510J	5-38
4R44		Same as 3R31	5-38
4R45		Same as 3R4	5-36
4R46		Same as 4R35	5-38
4R47		RESISTOR: MIL type RV5LAYSB102A	5-36
4R48		Not Used	
4R49		RESISTOR: MIL type RV4LAYSD501A	5-38
4R50		RESISTOR: MIL type RC20GF332K	5-38
4R51		Same as 2R65	5-35
4R52		RESISTOR: MIL type RC42GF123K	5-58
4R53		Same as 4R35	5-38
4R54		RESISTOR: MIL type RC32GF273K	5-58
4R55		RESISTOR: MIL type RC20GF152K	5-58

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4R56		Same as 3R36	5-35
4R57		Same as 3R31	5-38
4R58		RESISTOR: MIL type RC20GF182K	5-58
4R59		Same as 4R35	5-58
4R60		Same as 4R25	5-58
4R61		Same as 4R29	5-58
4R62		RESISTOR: MIL type RC20GF154K	5-38
4R63		Same as 3R42	5-38
4R64 & 4R65		Same as 3R62	5-58
4R66		RESISTOR: MIL type RC42GF102K	5-38
4R67		Same as 4R66	5-38
4R68		Same as 3R34	5-38
4R69		RESISTOR: MIL type RC20GF183K	5-38
4R70		Same as 3R41	5-38
4R71		Same as 4R54	5-38
4R72		RESISTOR: MIL type RC20GF822K	5-38
4R73		RESISTOR: MIL type RC42GF562K	5-38
4R74		Same as 4R73	5-38
4R75 thru 4R77		Same as 4R16	5-38
4R78		Same as 4R55	5-38
4R79 thru 4R86		Same as 4R16	5-38
4R87 & 4R88		RESISTOR: MIL type RC42GF470K	5-38
4R89 & 4R90		RESISTOR: MIL type RC20GF221K	5-38
4R91		RESISTOR: MIL type RN4NAYSD251A	5-35
4R92		RESISTOR: MIL type RC07GF151J	5-35
4R93		RESISTOR: MIL type RC07GF221J	5-35
4R94		RESISTOR: MIL type RC07GF124K	5-35
4R95		Same as 4R92	5-35
4R96		Same as 4R94	5-35
4R97		RESISTOR: MIL type RC07GF181J	5-35

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4R98		Same as 4R94	5-35
4R99		RESISTOR: MIL type RC07GF391J	5-35
4R100		Same as 4R94	5-35
4R101		RESISTOR: MIL type RC07GF471J	5-35
4R102		Same as 4R94	5-35
4R103		RESISTOR: MIL type RC07GF511J	5-35
4R104		Same as 4R94	5-35
4R105		Same as 4R99	5-35
4R106		Same as 4R94	5-35
4R107		RESISTOR: MIL type RC07GF152J	5-35
4R108		Same as 4R94	5-35
4R109		RESISTOR: MIL type RC07GF182J	5-35
4R110		Same as 4R94	5-35
4R111		RESISTOR: MIL type RC07GF222J	5-35
4R112		Same as 4R94	5-35
4R113		RESISTOR: MIL type RC07GF821J	5-35
4R114		Same as 4R94	5-35
4R115		RESISTOR: MIL type RC07GF102J	5-35
4R116		Same as 4R94	5-35
4R117		RESISTOR: MIL type RC07GF122J	5-35
4R118		Same as 4R94	5-35
4R119		Same as 4R115	5-35
4R120 & 4R121		RESISTOR: MIL type RC07GF103J	5-35
4R122		Same as 4R94	5-35
4R123		RESISTOR: MIL type RC07GF562J	5-35
4R124 thru 4R137		RESISTOR: MIL type RC20GF224K	5-36
4R138		RESISTOR: MIL type RC20GF100J	5-35
4R139		Same as 2R2	5-35
4R140		Same as 4R4	5-36
4R141		RESISTOR: MIL type RV5LAYSB502A	5-38
4R142		Same as 2R2	5-38
4R143		Same as 2R15	
4R144 & 4R145		RESISTOR: MIL type RC07GF683J	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4R146		RESISTOR: MIL type RC07GF104J	
4R147		RESISTOR: MIL type RV5LAYSB253A	5-36
4R148		Same as 2R95	5-36
4RT1 thru 4RT3		RESISTOR, THERMISTOR: 30,000 ohms, ±10%, mfr 04239, PN 24D2101; (Admiral PN 560B63-1)	
4S1		SWITCH, ROTARY: Three sections, six positions; mfr 70117, PN 576C199	5-36
4S2		SWITCH, ROTARY: One section, fifteen positions; mfr 76854, PN 196662-LK1; (Admiral PN 576B39)	5-36
4S3		SWITCH, ROTARY: One section, two positions; mfr 81716, PN 95655-A1; (Admiral PN 576C41)	5-35
4S4A-B & 4S5A-B		SWITCH, ROTARY: Four sections, eight positions; mfr 76854, PN 196661-F4; (Admiral PN 576B37)	5-35
4T1		TRANSFORMER, PULSE: Primary dc resistance 1.4 ohms, secondary dc resistance 11 ohms, pulse width 1.35 μsec, rise time 0.2 μsec; mfr 01961, PN PE2421; (Admiral PN 574C36-1)	5-36
4T2		TRANSFORMER, PULSE: Primary dc resistance 12.5 ohms, secondary dc resistance 29 ohms, pulse width 1.35 μsec, rise time 0.3 μsec; mfr 01961, PN PE2412; (Admiral PN 574C36-2)	5-36
4T3		TRANSFORMER, PULSE: Primary dc resistance 1 ohm, secondary dc resistance 8.5 ohms, pulse width 1 μsec, rise time 0.07 μsec; mfr 01961, PN PE2420; (Admiral PN 574C37)	5-36
4T4 & 4T5		Same as 2T2	5-36
4TB1		TERMINAL BOARD: Plastic, 1/16 in. thk, 3 in. dia, 28 terminals; mfr 70117, PN 532B281	
4V1		Same as 1V1	5-36
4V2		Same as 2V11	5-36
4V3		Same as 2V3	5-36
4V4		ELECTRON TUBE: MIL type 6AH6WA	5-36
4V5		Same as 3V6	5-36
4V6		Same as 4V4	5-36
4V7		Same as 3V1	5-36
4V8		Same as 2V11	5-36
4V9		ELECTRON TUBE: MIL type 12BY7	5-36
4V10		ELECTRON TUBE: MIL type 6J6WA	5-36
4V11 & 4V12		Same as 2V3	5-36
4XV1 thru 4XV3		Same as 1XV1	5-34

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4XV4		Same as 2XV5	5-38
4XV5		Same as 1XV1	5-38
4XV6 & 4XV7		Same as 2XV5	5-38
4XV8 & 4XV9		Same as 1XV1	5-38
4XV10		Same as 2XV5	5-38
4XV11 & 4XV12		Same as 1XV1	5-38
4Z1		DELAY LINE, NETWORK: Mfr 70117, PN GC1663	5-36
4A2		SIF CODER SUBASSEMBLY: Mfr 70117, PN GE4884	5-36
4A2C1		CAPACITOR: MIL type CK60BX680K	5-37
4A2C2		CAPACITOR: MIL type CS13BF105K	5-37
4A2C3		Same as 2C10	5-37
4A2C4		CAPACITOR: MIL type CK60BX100K	5-37
4A2C5		Same as 4A2C1	5-37
4A2C6		CAPACITOR: MIL type CK60AW102M	5-37
4A2C7 thru 4A2C9		CAPACITOR: MIL type CK60BX151K	5-37
4A2C10		Same as 4A2C2	5-37
4A2C11		CAPACITOR: MIL type CK60AX471K	5-37
4A2C12		CAPACITOR: MIL type CK60AX221K	5-37
4A2C13		CAPACITOR: MIL type CS13BC475K	5-37
4A2C14		CAPACITOR: MIL type CS13BE225K	5-37
4A2C15 thru 4A2C17		CAPACITOR: MIL type CL65BG101MP3	5-37
4A2C18		Same as 4A2C14	5-37
4A2CR1 thru 4A2CR6		SEMICONDUCTOR DIODE: MIL type 1N3064	5-37
4A2CR7		Same as 4CR8	5-37
4A2CR8 thru 4A2CR12		Same as 4A2CR1	5-37
4A2CR13 thru 4A2CR16		SEMICONDUCTOR DIODE: MIL type 1N483B	5-37

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4A2DL1		DELAY LINE: Time delay 0.3 μsec ±0.02 μsec; mfr 70117, PN 572C33	5-37
4A2E1		PRINTED CKT BOARD: 2 in. x 6.5 in. with twelve terminal studs; mfr 70117, PN GD4911	5-37
4A2L1		COIL, RF: MIL type MS75008-41	5-37
4A2L2 & 4A2L3		COIL, RF: MIL type MS75008-45	5-37
4A2L4		Same as 4A2L1	5-37
4A2Q1		TRANSISTOR: MIL type 2N2481	5-37
4A2Q2		TRANSISTOR: MIL type 2N2906	5-37
4A2Q3 thru 4A2Q5		Same as 4A2Q1	5-37
4A2Q6		Same as 4A2Q2	5-37
4A2Q7 thru 4A2Q9		Same as 4A2Q1	5-37
4A2Q10		Same as 4A2Q2	5-37
4A2R1		RESISTOR: MIL type RC07GF472J	5-37
4A2R2		Same as 4R111	5-37
4A2R3		RESISTOR: MIL type RC07GF331J	5-37
4A2R4		Same as 4R120	5-37
4A2R5		Same as 4A2R3	5-37
4A2R6		Same as 4R120	5-37
4A2R7		Same as 4R115	5-37
4A2R8		Same as 4R146	5-37
4A2R9		RESISTOR: MIL type RC07GF272J	5-37
4A2R10		Same as 4R120	5-37
4A2R11		Same as 4R109	5-37
4A2R12		RESISTOR: MIL type RC07GF332J	5-37
4A2R13		Same as 4R120	5-37
4A2R14		Same as 4A2R3	5-37
4A2R15		Same as 4R115	5-37
4A2R16		Same as 4A2R1	5-37
4A2R17		Same as 4R115	5-37
4A2R18 & 4A2R19		Same as 4A2R1	5-37
4A2R20		Same as 4R115	5-37
4A2R21		RESISTOR: MIL type RC07GF123J	5-37

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
4A2R22		Same as 4R111	5-37
4A2R23		Same as 4R120	5-37
4A2R24		Same as 4A2R21	5-37
4A2R25		Same as 4R120	5-37
4A2R26		RESISTOR: MIL type RC07GF101J	5-37
4A2R27		Same as 4R111	5-37
4A2R28		Same as 4A2R21	5-37
4A2R29		Same as 4A2R1	5-37
4A2R30		RESISTOR: MIL type RC07GF682J	5-37
4A2R31		Same as 4A2R1	5-37
4A2R32		Same as 4R120	5-37
4A2R33		Same as 4R109	5-37
4A2R34		RESISTOR: MIL type RC32GF820J	5-37
4A2RT1		RESISTOR, THERMISTOR: 68 ohms, ±10%; mfr 06228, PN TM 1/8-68OHMPORM10PCT; (Admiral PN 561D26-11)	5-37
4A2VR1		SEMICONDUCTOR DIODE: MIL type 1N3022B	5-37
5		MAIN CHASSIS: Mfr 70117, PN GJ4910	5-25
5C1		CAPACITOR, FIXED, PAPER: Two capacitors in one case, 10 μf, +20% -10%, 400 vdcw; and 20 μf, +20% -10%, 600 vdcw; mfr 14655, PN TNOR103-1; (Admiral PN 565C66)	5-26
5C2		CAPACITOR, FIXED, PAPER: 0.25 μf, ±20%, 400 vdcw; mfr 00656, PN P8292ZN.25UF400V; (Admiral PN 565D45-15)	5-26
5C3		Same as 1C41	5-26
5C4		CAPACITOR, FIXED, PAPER: Two capacitors in one case, 4 μf, ±20%, 400 vdcw, ungrounded, 4 μf, ±20%, 300 vdcw, grounded; mfr 71436, PN 2191; (Admiral PN 563C14)	5-26
5C5		CAPACITOR, FIXED, PAPER: 0.02 μf, ±20%, 200 vdcw; mfr 00656, PN P8292ZN.02UF200V; (Admiral PN 565D45-2)	5-26
5C6		Same as 3C16	5-26
5C7 & 5C8		Same as 3C19	5-26
5C9		Same as 4C6	5-26
5C10		CAPACITOR: MIL type CE53C350F	5-25
5C11 & 5C12		Same as 1C44	5-26
5CR1		RECTIFIER, METALLIC: Mfr 84970, PN S5092A; (Admiral PN 595B30)	5-25
5CR2		RECTIFIER, METALLIC: Mfr 84970, PN S5091; (Admiral PN 593B29)	5-25

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
5CR3		SEMICONDUCTOR DIODE: MIL type 1N2989B	5-26
5CR4		SEMICONDUCTOR DIODE: MIL type 1N748A	5-25
5DS1		LAMP INCANDESCENT: MIL type MS15571-2	5-24
5DS2 & 5DS3		INDICATOR, FUSE: Clear knob with neon lamp; mfr 71400, PN 6323-1/2; (Admiral PN 533B170)	5-23
5E1		Same as 1E1	
5E2		Same as 1E2	
5E3		Same as 1E3	
5E4		SHIELDING, GASKET: Black neoprene, with monel braided sleeving, 1/16 in. thk, 1/2 in. w, 62-1/2 in. lg; mfr 77969, PN AMS3208RC19081057; (Admiral PN 536B29-1)	5-25
5E5		Same as 3E6	5-25
5E6		Same as 1E11	5-25
5E7		SHIELD, TUBE: 1 in. dia, 2-1/2 in. lg; mfr 98978, PN TR6-6025H; (Admiral PN 587C35-68)	5-25
5E8		LAMP BASE: Part of 5XDS1; mfr 72619, PN 207-0410-01-201	5-25
5F1 thru 5F3		FUSE, CARTRIDGE: MIL type F02A250V6AS	5-24
5H1		SCREW, EXTERNALLY RELIEVED BODY: 2 in. lg, 9/16 threaded, 1/4-20 thd; mfr 94222, PN 54-99-177-24; (Admiral PN 501C33-14)	
5H2		WASHER, NONMETALLIC: Mica, 0.030 in. thk, 1/2 in. od, 3/16 in. id; mfr 70117, PN 505D1-58	
5H3		PIN, GROOVED, HEADED: 0.185 in. dia, 1-1/8 in. dia, 1-1/8 in. lg; mfr 70117, PN 508B20	
5H4		PIN, HEADLESS: 10-32 x 3/8 in. thd, 1-7/32 in. lg; mfr 70117, PN 527B464	
5H5		PIN, STRAIGHT: 1/4-20 x 7/16 in. thd, 7/8 in. lg; mfr 70117, PN 527B465	
5H6		RING, RETAINING: 0.335 in. od x 0.145 in. id; mfr 79136, PN 5133-18; (Admiral PN 518D29-7-102)	
5H7		RING, RETAINING: 0.527 in. od x 0.020 in. id; mfr 79136, PN 5133-25; (Admiral PN 518D29-8-102)	
5H8		SCREW, MACHINE: 10-32 x 7/8 in. fillister head; mfr 70117, PN 5102-875-F2-52	
5H9		Same as 1H1	
5J1		CONNECTOR, RECEPTACLE: 9 contacts, two guide pins, one male, one female; mfr 81312, PN MRA9PG/V; (Admiral PN 588C82-2)	5-25
5J2 thru 5J5		CONNECTOR, RECEPTACLE: 24 contacts, two hole mtg, 2-7/8 in. mtg centers; mfr 02660, PN 26-4200-24S; (Admiral PN 588C83-8)	5-25
5J6 & 5J7		Same as 2J3	5-25

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
5L1		REACTOR: Case size 3-17/32 in. lg, 3-1/16 in. w, 4-7/8 in. h, four mtg screws, 2-1/8 in. x 2-11/16 in. mtg centers; mfr 70117, PN 574B27	5-25
5L2		REACTOR: Case size 2-9/64 in. sq, 2-3/4 in. h, four mtg screws, 1-1/2 in. x 1-1/2 in. mtg centers; mfr 70117, PN 574C28	5-25
5MP1		BAR, STOP MECHANISM: 1/8 in. thk, 1/2 in. w, 5-11/16 in. lg, three holes spaced 1-21/32 in. and 5 in. apart; mfr 70117, PN 515A82-2	
5MP2		ARM, SWITCH ACTUATOR: "U" shape, 4-5/16 in. lg; mfr 70117, PN 515B866	
5MP3		GASKET: Black neoprene, 1/16 in. thk, 5/8 in. od x 7/32 in. id; mfr 70117, PN 512C1-49	
5MP4		RUBBER CHANNEL: 3/16 in. x 3/16 in. with channel, 4 ft lg; mfr 70117, PN 512A63-26	
5MP5		SHIM, PANEL MOUNTING: Aluminum, 7/32 in. thk, 3/8 in. w, 3/4 in. lg; mfr 70117, PN 516B188-1	
5MP6		SPRING, HELICAL: 1/4 in. od, 9/16 in. lg, with half loops at each end; mfr 70117, PN 519C12-2	
5MP7		PIVOT, STOP MECHANISM: 7/16 in. head 1/4 in. dia shank, 3/8 in. lg; mfr 70117, PN 527A47	
5MP8		BUSHING, SLEEVE: 5/8 in. dia, 3/8 in. lg, hole and shoulder thru the center; mfr 70117, PN 527B682	
5MP9		SPACER, SLEEVE: 3/16 in. dia, 9/32 in. lg; mfr 70117, PN 529C3-59-52	
5MP10		Not Used	
5MP11		CLAMP, BRIDGE: Mfr 70117, PN 533A103	
5MP12		HANDLE, BOW: 3/8 in. dia, "U" shape, 5/16-24 thd, 7 in. mtg ctr; mfr 70117, PN 537B71-1	5-25
5MP13		Same as 2MP3	5-26
5MP14		Same as 1MP28	5-26
5MP15		RETAINER, TUBE: Mfr 70117, PN 511D64-2NH	5-25
5MP16		RETAINER, TUBE: Mfr 70117, PN 511D64-7	5-25
5MP17		Same as 4MP3	5-26
5MP18		Same as 4MP2	5-26
5MP19		CLAMP, LOOP: Mfr 95987, PN WC 3/8-4; (Admiral PN 511D7-45)	5-26
5MP20		RETAINER, CAPACITOR: 17/32 in. loop, 5/64 in. x 1/4 in. mtg hole; mfr 70117, PN 511A60-2	
5MP21		RETAINER, TUBE: Mfr 07344, PN 926C-218; (Admiral PN 511D9-28)	5-25
5MP22		LENS, INDICATOR: Part of 5XDS1; mfr 72619, PN 208-0131-200	5-24
5R1 & 5R2		RESISTOR: MIL type RC32GF220J	5-26
5R3 thru 5R5		Same as 2R65	5-26

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
5R6 & 5R7		Same as 5R1	5-26
5R8		Same as 2R65	5-26
5R9		RESISTOR: MIL type RC20GF823K	5-26
5R10		RESISTOR: MIL type RC20GF563K	5-26
5R11		Same as 2R9	5-26
5R12		Same as 3R17	5-26
5R13		RESISTOR: MIL type RN70B2153F	5-26
5R14		RESISTOR: MIL type RN70B4003F	5-26
5R15		RESISTOR: MIL type RC42GF201J	5-26
5R16		Same as 5R15	5-26
5R17		RESISTOR: MIL type RE70G1801	5-26
5R18		Same as 2R2	5-26
5R19		Same as 2R53	5-26
5R20		RESISTOR: MIL type RC32GF223K	5-26
5R21		RESISTOR: MIL type RC20GF434J	5-26
5R22		Same as 4R55	5-26
5R23		Same as 2R53	5-26
5R24		RESISTOR: MIL type RN70B1783F	5-26
5R25		RESISTOR: MIL type RV4LAYSA104A	5-26
5R26		RESISTOR: MIL type RN70B2613F	5-26
5R27		RESISTOR: MIL type RC42GF223K	5-26
5R28		RESISTOR: MIL type RW29V312	5-26
5R29		RESISTOR: MIL type RC20GF431J	5-26
5R30 & 5R31		RESISTOR: MIL type RC32GF470K	5-26
5R32		Same as 2R53	5-26
5R33 & 5R34	In Fuse Holder	Same as 4R124	
5R35 & 5R36		Same as 5R15	5-26
5R37		Same as 1R88	5-26
5S1		SWITCH, THERMOSTATIC: Open at 74 $\pm 3^{\circ}C$, and closed at 63 $\pm 3^{\circ}C$, switch voltage 125 vac, inductive current 3.2 amp; mfr 70117, PN 577B43-5	5-25
5S2		SWITCH, INTERLOCK: Mfr 15605, PN 8909K559; (Admiral PN 577A6)	5-25
5S3		SWITCH, TOGGLE: MIL type MS35059-22	5-25

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

TEST SET, RADAR TS-1253A/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
5S4		SWITCH, THERMOSTATIC: Open 20 $\pm 5^{\circ}$F, closed at 50 $+7^{\circ}$F, switch voltage 125 vac, inductive current 1 amp; mfr 70117, PN 577B43	5-25
5T1		TRANSFORMER, POWER: Mfr 70117, PN 580C23-2	5-26
5V1 & 5V2		ELECTRON TUBE: MIL type 6080WA	5-25
5V3		Same as 2V9	5-25
5V4		ELECTRON TUBE: Mfr 73326, PN 6216	5-25
5V5		ELECTRON TUBE: MIL type 5651WA	5-25
5V6		Same as 2V11	5-25
5V7		LAMP, GLOW: Mfr 24455, PN NE86; (Admiral PN 581B6-2)	5-25
5XC10		Same as 1X21	5-26
5XCR1		SOCKET, TUBE: 5 pins; mfr 02660, PN 77A1P5T; (Admiral PN 587A37-2)	5-26
5XCR2		SOCKET, TUBE: 4 pins; mfr 02660, PN 77A1P4T; (Admiral PN 587A36-2)	5-26
5XDS1		LIGHT, INDICATOR: Mfr 72619, PN 208-0410-0131-201; (Admiral PN 582A8-1)	5-24
5XF1 & 5XF2		FUSEHOLDER: Mfr 71400, PN HKL-XE90-250V; (Admiral PN 584B5)	5-24
5XF3		FUSEHOLDER: Mfr 71400, PN HKL-AEJQRW; (Admiral PN 584B3-2)	5-25
5XV1 & 5XV2		Same as 1XZ1	5-26
5XV3 & 5XV4		Same as 1XV1	5-26
5XV5		Same as 2XV5	5-26
5XV6		Same as 1XV1	5-26

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

LEAD, TEST MX-2681/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
6		LEAD, TEST MX-2681/UP: Mfr 70117, PN GD1681-2	5-55
6A1		CONNECTOR ASSEMBLY: 6-1/2 ft radio frequency, cable and connector at both ends; mfr 70117, PN GC1483	5-55
6A2		Not Used	
6A3		CAPACITOR, BODY: Part of GB2525; mfr 70117, PN GB1678	5-55
6C1		CAPACITOR, VARIABLE, ASSEMBLY: Mfr 70117, PN GB2525	5-55
6C2		CAPACITOR: MIL type CY10C390J	5-55
6C3		CAPACITOR, VARIABLE: Ceramic dielectric, 7 pf to 25 pf; mfr 72982, PN 557-038; (Admiral PN 566D1-11)	5-55
6E1		STRAP, RETAINING: Part of GB1678; mfr 70117, PN 518B199	5-55
6E2		STRAP, RETAINING: Part of GB1678; mfr 70117, PN 518B200	5-56
6E3		CLAMP, ELECTRICAL: Mfr 70117, PN 518C201	5-56
6E4		CONTACT, ELECTRICAL: Part of GB1678; mfr 70117, PN 519B44-1	5-56
6E5		RETAINER, CORE: Part of GB2525; mfr 70117, PN 527C453	5-56
6E6		CONTACT, ELECTRICAL: Part of GB2525; mfr 70117, PN 519B44-2	5-56
6E7		TIP TEST PROD: Part of GD1681-2; mfr 70117, PN 527B91	5-55
6E8		CORE, VARIABLE: Steel rod, 1-9/16 in. lg, with 6-32 x 1/4 in. thd, at one end; mfr 70117, PN 527B454	5-56
6E9		DIELECTRIC, VARIABLE: Part of GB1678; mfr 70117, PN 533C100	5-55
6MP1		GASKET: Black neoprene, 1/32 in. thk, 3/16 in. od, 1/16 in. id, mfr 70117, PN 512C1-33	5-55
6MP2		PACKING, PREFORM: Neoprene, "O" ring, 1/16 in. dia, 3/8 in. od, 1/4 in. id; mfr 96188, PN PRP-902-5; (Admiral PN 512D2-2)	5-55
6MP3		PLUG, PROTECTIVE: Dust and moisture seal; mfr 78189, PN 207-120241-05; (Admiral PN 513D12-1)	5-55
6MP4		BUSHING, SLEEVE: 1/4 in. dia, with 5/16 in. sq shoulder, 10-32 thd thru ctr; mfr 70117, PN 527B452	5-55
6MP5		BUSHING, SLEEVE: Neoprene, 17/64 in. dia, 13/32 in. lg; mfr 70117, PN 512B135	5-55
6MP6		HOLDER, TIP, PROD: Mfr 70117, PN 527B455	5-55
6MP7		SPACER, SLEEVE: Nylon, 3/32 in. thk, 3/16 in. dia, 3/32 in. hole thru ctr; mfr 70117, PN 529C6-14	5-55
6MP8		KNOB: Plastic; mfr 70117, PN 533C93	5-55
6MP9		BODY, PROBE: Mfr 70117, PN 534J22-3	5-55
6MP10		BUSHING, SLEEVE: Mfr 70117, PN 527B451	5-55
6MP11		BUSHING: Hex head, 11/16 in. overall lg, 10-32 x 1/4 in. thd, 0.104 hole thru ctr; mfr 70117, PN 527B450	5-55
6MP12		CLIP, ELECTRICAL: Mfr 76545, PN 60; (Admiral PN 590B6)	5-55
6MP13		INSULATION, HOOD: Black vinyl, 1/2 in. dia, 2-1/32 in. lg; mfr 76545, PN 62; (Admiral PN 533B127-2)	5-55
6P1		CONNECTOR, PLUG: Mfr 94375, PN 039B1700C; (Admiral PN 588B81-2)	5-55

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

LEAD, TEST MX-2681/UP

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
6R1		RESISTOR, FIXED, FILM: 7.88 megohms, ±1%, 1/2 watt; mfr 75042, type MDC7.88M1PCT; (Admiral PN 560C29-99)	5-55
6S1		SWITCH, ASSEMBLY: Mfr 70117, PN GB1502	5-55
6TB1		TERMINAL BOARD: Mfr 70117, PN GB1677	5-55
6W1		CABLE, RF: Mfr 98278, PN 93-3913; (Admiral PN 595C12-4)	5-55

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CASE, ELECTRICAL EQUIPMENT CY-2726A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
7		CASE, ELECTRICAL EQUIPMENT CY-2726A/UPM-98: Mfr 70117, PN GJ4707	5-22
7B1		FAN, AXIAL: 115 v, 45/420 cycle; mfr 02598, PN 53-11428; (Admiral PN GD4921)	5-22
7C1		CAPACITOR: MIL type CP04A1KF684K3	5-22
7C2		CAPACITOR: MIL type CP04A1KF564K3	5-22
7FL1		FILTER, RADIO INTERFERENCE: Mfr 56289, PN 14C437D; (Admiral PN 573C36-2)	5-22
7H1		PIN, HEADLESS: 0.358 in. dia, 1-1/2 in. lg on 1-3/8 in. dia x 3/8 in. thk base; mfr 70117, PN 527B463-1	
7MP1		GASKET: Black neoprene, 1/16 in. thk, 3 in. x 4 in. od, 2-1/4 in. x 3-1/4 in. id; mfr 70117, PN 512A72	
7MP2		GASKET: Black neoprene, 1/32 in. thk, 4-1/2 in. x 5-3/4 in. od, 3-1/2 in. x 4-3/4 in. id; mfr 70117, PN 512B106	
7MP3		PLUG, PROTECTIVE: Dust and moisture seal; mfr 78189, PN 207-080SS1-00-0101; (Admiral PN 513B12-2)	
7MP4		LOUVER, METAL: 4-1/2 in. x 5-3/4 in. overall dim, with five louvers; mfr 70117, PN 515B654-1	5-22
7MP5		WIRE, FABRIC: 4-7/8 in. x 9-7/16 in. overall dim; mfr 70117, PN 536C49	
7MP6		FILTER, AIR CONDITIONING: Aluminum frame, 4-31/32 in. x 7-7/32 in.; mfr 82866, PN AF-1952-B; (Admiral PN 536B25)	5-22
7MP7		FILTER: 1/4 in. thk, 13/16 in. w, 7-3/8 in. lg; mfr 82866, PN 9200X; (Admiral PN 536B37)	5-22
7MP8		HANDLE, BAIL: Mfr 57068, PN 1205-4; (Admiral PN 537A8-1)	1-1
7MP9		GASKET, CONNECTOR: Black neoprene, 1-3/16 in. sq; mfr 70117, PN 512A228	
7MP10		GASKET: Black neoprene, 6 in. x 10-3/4 in. overall with 4-15/16 in. x 9-1/2 in. cut off, twelve 0.196 in. holes; mfr 70117, PN 512C222	
7P1		Not Used	
7P2 & 7P3		CONNECTOR, PLUG: Mfr 81312, PN MRA9SGH/VL; (Admiral PN 588C82-3)	5-22
7TB1 & 7TB2		TERMINAL BOARD: Plastic, 7/8 in. w, 3-1/8 in. lg, six terminals, two mtg holes, 2-5/16 in. mtg ctr; mfr 70117, PN 510B21-2	5-22
7TB3		TERMINAL BOARD: Plastic, 11/16 in. w, 2-5/8 in. lg, six terminals, two mtg holes, 2-5/16 in. mtg ctr; mfr 70117, PN 510B27-1	5-22
7A1		CASE ASSEMBLY: Mfr 70117, PN GC4892	5-22
7A1C1		CAPACITOR: MIL type CL65BH400MP3	5-23
7A1CR1 thru 7A1CR4		Same as 4A2CR13	5-23
7A1R1		RESISTOR: MIL type RC32GF331K	5-23
7A1T1		TRANSFORMER, POWER: Mfr 70117, PN 580C107	5-23
7A1VR1		SEMICONDUCTOR DEVICE, DIODE: MIL type 1N3030B	5-23

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER, SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8,9,12		CODER, SIMULATOR SM-197A/UPM-98: Mfr 70117, PN GJ4708	5-40
8		CODER, SIMULATOR: Mfr 70117, PN GJ4846	5-40
8A1		OSCILLATOR, RF: Mfr 70117, PN GD1658	5-40
8A2		ALC/ATTENUATOR: Mfr 70117, PN GD1662-4	5-40
8A3		WAVEMETER ASSEMBLY: Mfr 70117, PN GD213-2	5-40
8A4		DETECTOR, RF: Mfr 70117, PN GC1770	5-40
8A5		PLATE ASSEMBLY: Demodulator; mfr 70117, PN GD287-2	5-40
8A6		COUPLING ASSEMBLY: Mfr 70117, PN GB220	5-40
8A7		DIAL, CONTROL: Assembly; mfr 70117, PN GC1661	5-40
8A8		Not Used	
8A9		DIRECTIONAL COUPLER: Assembly; mfr 70117, PN GC4290	5-40
8C1		CAPACITOR, FIXED, CERAMIC: 200 pf ±20%, 500 vdcw, 1/2 in. hex head, 7/16-28 thd; mfr 71590, PN DA908-001; (Admiral PN 565A11)	5-6
8C2		CAPACITOR, FIXED, MICA: Button type, 25 pf, ±10%, 500 vdcw; mfr 72982, PN 651-00218A0250K; (Admiral PN 565C7-3)	5-6
8C3		CAPACITOR, FIXED, MICA: Button type, 25 pf, ±10%, 500 vdcw; mfr 72982, PN 653-00018A0250K; (Admiral PN 565C7-4)	5-6
8C4 & 8C5		Same as 8C2	5-6
8C6		Same as 8C3	5-5
8C7		For Reference only	
8C8		CAPACITOR, FIXED, MICA: Button type, 500 pf, ±10%, 500 vdcw; mfr 72982, PN 653-501K; (Admiral PN 565C7-6)	5-5
8C9		CAPACITOR, FIXED, MICA: Button type, 500 pf, ±10%, 500 vdcw; mfr 72982, PN 651-02; (Admiral PN 565C7-5)	5-5
8C10		CAPACITOR, FIXED, MICA: Button type, 100 pf, ±10%, 500 vdcw; mfr 72982, PN 370CH501K; (Admiral PN 565C7-2)	
8C11		CAPACITOR, FIXED: 0.120 in. dia, 0.195 in. lg; mfr 78616, PN 950034; (Admiral PN 509B14-3)	5-55
8C12		CAPACITOR, FIXED: Assembly, 15 pf, +10%, 500 vdcw; mfr 70117, PN GA251	5-55
8C13		CAPACITOR: MIL type CC21CK2R2D	5-8
8C14		CAPACITOR: MIL type CB11ND101K	5-8
8C15		CAPACITOR: MIL type CE51C501G	5-40
8C16 & 8C17		Same as 4C6	5-41
8C18		CAPACITOR: MIL type CP70B1FF106K	5-41
8C19		Same as 3C4	5-41
8C20		Same as 5C2	5-41

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER, SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8CR1		SEMICONDUCTOR, DIODE: MIL type 1N25	5-40
8CR2		Same as 5CR1	5-40
8CR3		Same as 5CR2	5-40
8CR4 thru 8CR8		Not Used	
8CR9		Same as 5CR3	5-41
8DS1		Same as 5DS1	5-39
8DS2 & 8DS3		Same as 5DS2	5-39
8E1		Same as 1E1	5-40
8E2		Same as 1E2	
8E3		Same as 1E3	
8E4		SHIELDING, GASKET: Black neoprene, metal braid sleeving, 6-1/2 in. lg; mfr 77969, PN AMS3208RC19081057; (Admiral PN 536B29-2)	5-40
8E5		Same as 3E6	5-40
8E6		SHIELD, TUBE: MIL type TS102U03	5-40
8E7		CONTACT, ELECTRICAL: Metal, 0.046 in. thk, 0.156 in. dia; mfr 70117, PN 527A133	
8E8		SHIELD, SOCKET: Metal, cup shape 1.625 in. dia, 1/2 in. h; mfr 70117, PN 585B22	
8E9		SHIELDING, GASKET: Wire mesh, knitted, 1/8 in. thk, 5/32 in. w, 4-11/16 in. lg; mfr 07700, PN 10102; (Admiral PN 536A27-2)	
8E10		Same as 5E8	
8F1 thru 8F3		FUSE, CARTRIDGE: MIL type F02A250V4AS	5-39
8H1		Same as 5H1	5-39
8H2		Same as 5H8	5-39
8H3		Same as 5H6	5-39
8H4		Same as 5H7	
8H5		Same as 5H4	
8H6		Same as 5H5	
8H7		INSULATOR, BUSHING: Plastic, 31/64 in. dia, 5/16 in. lg; mfr 70117, PN 532A69	
8H8		NUT, KNURLED: Cup shape, 5/8 in. dia, 17/32-40 x 7/32 in. deep thd; mfr 70117, PN 527A125-2	
8J1		CONTACT ASSEMBLY: Mfr 70117, PN GB4285	5-40
8J2		Not Used	
8J3 thru 8J5		For Reference Only	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER, SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8J6		CONNECTOR, RECEPTACLE: MIL type UG291C/U	5-39
8J7 thru 8J10		For Reference Only	
8J11		CONNECTOR, SHELL: UG-89/U body, less contact and packing glands; mfr 70117, PN 588A22-3	5-40
8J12		For reference only	
8J13		CONNECTOR, RECEPTACLE: MIL type UG-290A/U	5-39
8J14		CONNECTOR, RECEPTACLE: UG290/U modified; mfr 70117, PN 588A2-2	5-39
8J15		Same as 8J13	5-39
8J16 & 8J17		Not Used	
8J18		Same as 8J1	5-40
8J19 & 8J20		Same as 8J13	5-41
8J21		Same as 5J1	5-40
8J22 & 8J23		CONNECTOR, RECEPTACLE: 16 contacts, two hole mtg, 2-1/8 in. mtg ctrs; mfr 02660, PN 26-4200-16S; (Admiral PN 588C83-6)	5-41
8J24 thru 8J52		Not Used	
8J53		CONNECTOR, PLUG: Single contact, bulkhead mtg; mfr 98291, PN 52-015-00007023; (Admiral PN 588C221)	5-40
8L1 thru 8L4		For Reference Only	
8L5		COIL, RF: Copperweld, 2 turns, 0.166 in. dia, silver plated; mfr 70117, PN 573A3	5-5
8L6 thru 8L8		For Reference Only	
8L9		COIL, RF: Phosphor bronze, 5 turns 3/16 in. dia, 13/16 in. lg, silver plated; mfr 70117, PN 573A2	5-55
8L10		COIL, RF: MIL type MS75008-23	5-8
8L11		REACTOR: Case size 2-13/64 in. x 2-17/32 in. and 3-3/32 in. h, four mtg screws 1-1/2 in. mtg ctrs, winding dc resistance 70 ohms; mfr 70117, PN 574B30	5-41
8L12 & 8L13		For Reference Only	
8M1		METER, TIME: MIL type MS17321-1	5-39
8MP1		DIAL SCALE: Aluminum, black background, white characters, 0 to 100; mfr 70117, PN 522B21	5-40

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER, SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8MP2		KNOB: Pointer, black bakelite; mfr 75376, PN S-246-3L-BB; (Admiral PN 533B104)	5-39
8MP3		KNOB: Black bakelite, 1-5/8 in. dia; mfr 75376, PN SCH-309-64-BB; (Admiral PN 533B105-1)	5-39
8MP4		KNOB: Black bakelite, 1-5/8 in. dia; mfr 75376, PN SCH-309-70-BB; (Admiral PN 533B105-2)	5-39
8MP5		RETAINER, TUBE: Mfr 70117, PN 511D64-4	5-40
8MP6		Same as 4MP2	
8MP7		GEAR, CLUSTER: Mfr 70117, PN GB1615	5-9
8MP8		GEAR, CLUSTER: Mfr 70117, PN GB1616	5-9
8MP9		GEAR, CLUSTER: Mfr 70117, PN GB1617	5-9
8MP10		GEAR, SPUR: Mfr 70117, PN GB1618	5-9
8MP11		GEAR, SPUR: Mfr 70117, PN GB1619	5-9
8MP12		GEAR, SPUR: Mfr 70117, PN GB1620	5-9
8MP13		GEAR, BEVEL: Mfr 70117, PN 530B101	5-9
8MP14		GEAR, BEVEL: Mfr 70117, PN 530C62-8	5-9
8MP15		COUNTER, ROTATING: Four wheels, white figures on black background; mfr 18911, PN AY40243-427-R-AC; (Admiral PN 559B19)	5-39
8MP16		COUNTER, ROTATING: Three wheels, white figures on black background; mfr 18911, PN 3Y8822-R-AC; (Admiral PN 559B18)	5-39
8MP17		GASKET: Black neoprene, 1/32 in. thk, 2-1/8 in. x 4 in. with 13/16 in. x 2-15/16 cut out; mfr 70117, PN 512A40	
8MP18		GASKET: Cork neoprene composition, 1/64 in. thk, 1-7/16 in. x 1-29/32 in. with 13/16 x 1-17/32 in. cut out; mfr 70117, PN 512A149	
8MP19		Same as 5MP1	
8MP20		Same as 5MP2	
8MP21		FRAME, WINDOW: Aluminum, 1-1/2 in. x 1-29/32 in. with 3/4 in. x 1-9/32 in. cut out; mfr 70117, PN 515B1018	
8MP22		Same as 5MP6	
8MP23		WINDOW, DIAL: Plexiglass, 0.040 in. thk, 1-1/2 in. x 1-29/32 in. painted surface, window opening 3/8 in. x 43/64 in.; mfr 70117, PN 521A19	5-39
8MP24		WINDOW, DIAL: Plexiglass, 0.040 in. thk, 1-1/2 in. x 1-29/32 in. painted surface, window opening 3/8 in. x 63/64 in.; mfr 70117, PN 521A20	5-39
8MP25		WINDOW, DIAL: Plexiglass, 0.040 in. thk, 1-7/16 in. x 1-29/32 in. painted surface, window opening 3/8 in. x 1-7/32 in.; mfr 70117, PN 521A21	5-39
8MP26		Same as 5MP11	
8MP27		HANDLE, BOW: 3/8 in. dia, "U" shape, 5/16-24 thd, 6 in. mtg ctr; mfr 70117, PN 537B71-2	5-40
8MP28		POST, BINDING: Mfr 72825, PN 6639; (Admiral PN 509C74-1)	
8MP29		Same as 1MP2	
8MP30		Same as 3MP2	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8MP31		Same as 2MP1	
8MP32		GASKET: 3/32 in. thk, 11/32 in. od, 16/64 in. id; mfr 70117, PN 512C1-10	
8MP33		Same as 5MP5	5-39
5MP34		CLIP, SPRING: 1/2 in. dia; mfr 80033, PN 500-500; (Admiral PN 518C20-2)	
8MP35		Same as 5MP7	
8MP36		Same as 5MP8	
8MP37		Same as 2MP3	
8MP38		Same as 5MP22	
8P1 & 8P2		Not Used	
8P3		For Reference Only	
8P4		CONNECTOR, PLUG: MIL type UG-88F/U	5-40
8P5		For Reference Only	
8P6		Not Used	
8P7		For Reference Only	
8P8 thru 8P11		Same as 8P4	5-40
8P12		CONNECTOR, PLUG: MIL type MS35170-260E	5-40
8P13 & 8P14		Not Used	
8P15		DUMMY LOAD: Resistor 51 ohms, ±5%, 1/2 watt, in cap and chain; mfr 74868, PN 6850; (Admiral PN 588C87-3)	5-39
8P16 thru 8P18		Not Used	
8P19 & 8P20		CONNECTOR, PLUG: MIL type UG-260D/U	5-40
8P21 thru 8P51		Not Used	
8P52		CONNECTOR, PLUG: Mfr 94375, PN 819-T1800; (Admiral PN 588C224)	5-40
8P53		CONNECTOR, PLUG: Mfr 74868, PN 1PC77175; (Admiral PN 588C222)	5-40
8R1		RESISTOR: MIL type RC20GF150J	5-6
8R2 & 8R3		Same as 1R54	5-6
8R4		RESISTOR, FIXED, COMPOSITION: 75 ohms, ±5%, 1/2 watt, formed for electrical reason; mfr 70117, PN 560A38	5-8

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8R5		RESISTOR, FIXED, COMPOSITION: 160 ohm, ±5%, 1/2 watt, formed for electrical reason; mfr 70117, PN 560A39	5-8
8R6	P/o A4	RESISTOR, FIXED, COMPOSITION: 160 ohm, ±5%, 1/2 watt, formed for electrical reason; mfr 70117, PN 560A36	5-40
8R7	P/o A4	RESISTOR, FIXED, COMPOSITION: 11 ohm, ±5%, 1/2 watt, formed for electrical reason; mfr 70117, PN 560A35	5-40
8R8		For Reference Only	
8R9	P/o A4	RESISTOR, FIXED, COMPOSITION: 130 ohm, ±5%, 1/2 watt, formed for electrical reason; mfr 70117, PN 560A37	5-40
8R10	P/o A4	RESISTOR, FIXED, COMPOSITION: 100 ohm, ±5%, 2 watt, formed for electrical reason; mfr 70117, PN 560A41	5-40
8R11	P/o A4	RESISTOR, FIXED, COMPOSITION: 47 ohm, ±5%, 2 watt, formed for electrical reason; mfr 70117, PN 560A42	5-40
8R12 & 8R13		For Reference Only	
8R14	P/o A4	RESISTOR, FIXED, COMPOSITION: 27 ohm, ±5%, 2 watt, formed for electrical reason; mfr 70117, PN 560A40	5-40
8R15	P/o 8P15	Same as 4R43	5-39
8R16		Not Used	
8R17		RESISTOR: MIL type RC32GF683K	5-41
8R18		RESISTOR: MIL type RC32GF823K	5-41
8R19		RESISTOR: MIL type RW29V801	5-41
8R20		RESISTOR: MIL type RC42GF181J	5-41
8R21		Same as 1R51	5-41
8R22		RESISTOR: MIL type RC32GF181J	5-41
8R23		Same as 4R1	5-41
8R24		RESISTOR: MIL type RC32GF753J	5-41
8R25		Same as 3R41	5-41
8R26		Same as 2R2	5-41
8R27		RESISTOR: MIL type RC32GF470J	5-41
8R28		Same as 2R2	5-41
8R29		RESISTOR: MIL type RW20V402	5-41
8R30		Same as 8R27	5-41
8R31		Same as 1R58	5-41
8R32		Same as 2R2	5-41
8R33		Same as 4R62	5-41
8R34		Same as 2R14	5-41
8R35		RESISTOR: MIL type RV4LAYSA253A	5-41
8R36		Same as 3R18	5-41

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8R37		RESISTOR, MIL TYPE RW20V632	5-41
8R38 & 8R39	In Fuse Holder	Same as 4R124	5-40
8R40		Same as 8R1	5-5
8R41		Same as 2R2	5-41
8S1		SWITCH, RF: Three position coaxial; mfr 70117, PN 576C122-3	5-9
8S2		Same as 5S3	5-40
8S3		Same as 5S2	5-40
8T1		TRANSFORMER, POWER: Mfr 70117, PN 580C25-2	5-41
8TP1 & 8TP2		Same as 2J3	5-40
8TP3		JACK, TIP: MIL type MS16108-2	5-40
8TP4		Same as 2J3	5-40
8V1	P/o A2	ELECTRON TUBE: MIL type 2B22	5-40
8V2	P/o A1	ELECTRON TUBE: MIL type 2C36	5-40
8V3		Same as 8V1	5-40
8V4		Same as 5V1	5-40
8V5		Same as 3V1	5-40
8V6		Same as 5V5	5-40
8V7		ELECTRON TUBE: MIL type OB2WA	5-40
8W1		CABLE ASSEMBLY, RF: 1 ft lg, c/o RG-223/U cable RF, and two UG-88E/U connectors; mfr 70117, PN GC2026-15	5-40
8W2		CABLE ASSEMBLY, RF: 10 on. lg, c/o RG-223/U cable RF, one UG-88C/U connector and one GA238 probe subassembly; mfr 70117, PN GC221-2	5-40
8W3		CABLE ASSEMBLY, RF: 5 in. lg, c/o RG-223/U cable RF, and two UG-88E/U connectors; mfr 70117, PN GC2026-3	5-40
8W4		CABLE ASSEMBLY, RF: 10 in. lg, c/o RG-62A/U cable RF, and two UG-260E/U connectors; mfr 70117, PN GC2026-14	5-40
8W5		CABLE ASSEMBLY, RF: 15 in. lg, c/o RG-62A/U cable RF, one UG-260E/U and one special connector; mfr 70117, PN GB2124-1	5-40
8W6		CABLE ASSEMBLY, RF: 10 in. lg, c/o RG-223/U cable RF, one 537B72 and one 588C222 connector; mfr 70117, PN GC4752	5-40
8W7		CABLE ASSEMBLY, RF: 15 in. lg, c/o RG-62A/U cable RF, and one special termination; mfr 70117, PN GA493-2	5-40
8W8		CABLE ASSEMBLY, RF: 14 in. lg, c/o RG-188A/U cable RF, one 588C224 and one 588C221 connector; mfr 70117, PN GC4566	5-40
8W9		CABLE ASSEMBLY, RF: 1 ft lg, c/o RG-223/U and one RF termination, mfr 70117, PN GA5022	5-40
8XC1		Same as 1XZ1	5-40

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
8XCR1		Not Used	
8XCR2		Same as 5XC1	5-41
8XCR3		Same as 5XCR2	5-41
8XDS1		Same as 5XCS1	5-39
8XF1 & 8XF2		Same as 5XF1	5-39 & 5-40
8XF3		Same as 5XF3	
8XV1		SOCKET, TUBE: Eight pin, two hole mtg, 1-1/2 in. mtg ctr; mfr 02660, PN 77M1P-8THM; (Admiral PN 587B9-2)	5-41
8XV2		Not Used	
8XV3		SOCKET, TUBE: Shield and capacitor assembly on socket; mfr 70117, PN GB2208	5-42
8XV4		Same as 1XZ1	5-41
8XV5 thru 8XV7		Same as 2XV5	5-41
8Z1		FILTER, ASSEMBLY: 0.562 in. dia x 2.046 in. lg; mfr 70117, PN GB296-1	5-40
8Z2		FILTER, LOW PASS: 0.460 in. dia x 2.014 in. lg; mfr 70117, PN 301-2	5-40
8Z3		FILTER, ASSEMBLY: 0.562 in. dia x 2.046 in. lg; mfr 70117, PN GB297-2	5-40
8Z4		ATTEN, SUBASSEMBLY: Four turns of wire on resistor, 130 ohm, ±5%, 1 watt; mfr 70117, PN GA253	5-40
8Z5		ATTEN, SUBASSEMBLY: Two and one quarter turns on resistor, 3900 ohm, ±5%, 2 watt; mfr 70117, PN GA254	5-40
8Z6		ATTEN, SUBASSEMBLY: Two turns close wound on resistor, 150 ohm, ±5%, 1/2 watt; mfr 70117, PN GA255	5-40
8Z7		WAVEMETER, SUBASSEMBLY: Holder for 1N25 semiconductor, diode; mfr 70117, PN GB222	5-40
9		CAL-CONTROL: Mfr 70117, PN GJ4839	5-51
9A1		SWITCH SUBASSEMBLY: Three section, ten position, with resistors and coil; mfr 70117, PN GD4981	5-51
9A2		METER, SWITCH, SUBASSEMBLY: Two section, four position, with variable resistor and capacitor; mfr 70117, PN GD4982	5-52
9A3		Not Used	
9C1		Same as 1C48	5-51
9C2		Not Used	
9C3		Same as 3C8	5-51
9C4		CAPACITOR: MIL type CM05F301J03	5-51
9C5		Same as 2C18	5-51

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9C6 & 9C7		Same as 2C19	5-51
9C8		Same as 3C8	5-51
9C9		Same as 1C48	5-51
9C10		Same as 4C6	5-52
9C11		CAPACITOR: MIL type CP05A1KE224K3	5-53
9C12		Same as 5C2	5-53
9C13		CAPACITOR, FIXED, PAPER: 0.01 μf, ±20%, 600 vdcw; mfr 70117, PN 565D45-19	5-51
9C14		Same as 4C6	5-51
9C15		Same as 3C8	5-51
9C16		Same as 1C41	5-53
9C17		Same as 3C4	5-51
9C18		Same as 3C8	5-52
9C19		Same as 1C48	5-53
9C20		Same as 2C18	5-51
9C21		Same as 1C48	5-52
9C22		Same as 1C27	5-51
9C23		CAPACITOR: MIL type CP05A1KC473K3	5-53
9C24		Same as 3C8	5-51
9C25		Same as 5C2	5-52
9C26		Same as 1C34	5-51
9C27		Same as 5C2	5-52
9C28		CAPACITOR, FIXED, PAPER: 2 μf, ±10%, 400 vdcw; mfr 72928, PN XG-1897NT-10; (Admiral PN 565C8-28)	5-52
9C29		CAPACITOR: MIL type CM07F123J03	5-52
9C30		CAPACITOR: MIL type CM06F122J03	5-52
9C31 & 9C32		Not Used	
9C33		Same as 1C4	5-51
9C34		Same as 2C17	5-51
9C35		Same as 2C10	5-51
9C36 & 9C37		CAPACITOR: MIL type CK63AW103M	5-51
9CR1		Same as 2CR6	5-51

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9CR2 & 9CR3		Same as 1CR5	5-51
9CR4 & 9CR5		Same as 1CR1	5-51
9CR6		Same as 1CR5	5-51
9CR7		SEMICONDUCTOR, DIODE: MIL type 1N3064	5-51
9DL1		DELAY LINE: 0.7/16 in. dia, 3-5/16 in. lg, 2.5 μsec time delay; mfr 70117, PN 572D14-1	5-52
9E1		Same as 1E8	5-52
9E2		Same as 1E11	5-52
9E3 & 9E4		Same as 3E6	5-52
9E5		Same as 1E2	5-51
9E6		Same as 1E3	5-52
9E7		TERMINAL, STUD: Threaded, hex shoulder, 4-40 x 5/32 in. deep thread; mfr 98291, PN RST-SM-31TUR; (Admiral PN 509A21-2)	5-52
9E8		Same as 1E1	5-52
9J1		Not Used	
9J2 thru 9J4		Same as 1J1	5-52
9J5 thru 9J8		Same as 2J3	5-52
9J9 & 9J10		Same as 1J1	5-51 5-52
9L1		Same as 4L7	5-51
9L2		Same as 4L1	5-51
9M1		AMMETER: MIL type MR26W-500DCUAR	5-52
9MP1		Same as 1MP24	5-39
9MP2		Same as 1MP26	5-39
9MP3		HANDLE, BOW: 3/16 in. dia, "U" shape, 6-32 x 5/16 in. thd, 7/8 in. mtg ctrs; mfr 70117, PN 537B70-2	5-39
9MP4		CLAMP, LOOP: Black nylon 5/8 in. dia; mfr 95987, PN WC 5/8-2-140; (Admiral PN 511D7-54)	5-52
9MP5		Same as 3MP5	
9MP6		Same as 2MP3	5-51
9MP7		Same as 1MP28	5-51

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9P1		CONNECTOR, RECEPTACLE: 16 contact, two hole mtg 2-1/8 in. mtg ctrs; mfr 70117, PN 588C83-5	5-52
9P2 & 9P3		Not Used	
9P4		CONNECTOR, RECEPTACLE: 1/8 in. thk, 1-1/64 in. w, 1-1/32 in. lg, plastic board, with four contacts; mfr 70117, PN GB4284	5-51
9R1		RESISTOR: MIL type RC20GF561J	5-51
9R2		Same as 5R10	5-51
9R3		RESISTOR: MIL type RV2LAYSA503A	5-52
9R4		Same as 4R124	5-51
9R5		Same as 2R53	5-53
9R6		Same as 3R14	5-51
9R7		Same as 2R10	5-51
9R8		Same as 2R68	5-51
9R9		Same as 1R71	5-51
9R10		Same as 3R41	5-51
9R11		Same as 3R81	5-51
9R12		Same as 2R10	5-51
9R13		Same as 3R5	5-51
9R14		Same as 2R10	5-51
9R15		Same as 3R41	5-51
9R16		RESISTOR: MIL type RC20GF223K	5-51
9R17		RESISTOR: MIL type RC20GF124J	5-51
9R18		Same as 2R74	5-51
9R19		Same as 2R17	5-51
9R20		Same as 1R46	5-51
9R21		RESISTOR: MIL type RC20GF681J	5-51
9R22		Same as 2R107	5-51
9R23		Same as 2R53	5-51
9R24		Same as 3R57	5-51
9R25		RESISTOR: MIL type RC20GF223J	5-51
9R26		RESISTOR: MIL type RC20GF473J	5-51
9R27		Same as 2R15	5-51
9R28		RESISTOR: MIL type RC20GF361J	5-51
9R29		RESISTOR: MIL type RC20GF433J	5-51
9R30 & 9R31		Same as 2R86	5-52

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9R32		Same as 1R39	5-51
9R33		RESISTOR: MIL type RN70B1200F	5-52
9R34		RESISTOR: MIL type RN70B5361F	5-51
9R35		RESISTOR: MIL type RE70G4991	5-51
9R36		Same as 2R50	5-52
9R37		RESISTOR: MIL type RN80B1601F	5-51
9R38		RESISTOR: MIL type RN70B2000F	5-52
9R39		Same as 9R33	5-51
9R40		RESISTOR: MIL type RN70B80R0F	5-52
9R41		Same as 4R14	5-52
9R42		Same as 3R32	5-51
9R43		Same as 4R14	5-52
9R44		RESISTOR: MIL type RC20GF390K	5-51
9R45		RESISTOR: MIL type RV4NAYSB251A	5-51
9R46		RESISTOR: MIL type RC20GF201J	5-51
9R47		Same as 4R36	5-51
9R48		Same as 4R14	5-51
9R49		Same as 2R15	5-51
9R50		Same as 2R9	5-52
9R51		Same as 3R72	5-52
9R52		Same as 3R5	5-51
9R53		Same as 2R53	5-51
9R54		RESISTOR: MIL type RC20GF393K	5-51
9R55		Same as 2R2	5-51
9R56		Same as 9R16	5-51
9R57		RESISTOR: MIL type RC20GF824K	5-51
9R58		Same as 2R56	5-51
9R59		Same as 4R11	5-51
9R60		Same as 9R16	5-51
9R61		Same as 2R86	5-52
9R62		RESISTOR: MIL type RC20GF475K	5-51
9R63		Same as 4R4	5-52
9R64		RESISTOR: MIL type RN70B1000F	5-52
9R65		Same as 9R40	5-51
9R66		RESISTOR: MIL type RN70B20R0F	5-52
9R67		Same as 9R26	5-51
9R68		RESISTOR: MIL type RC32GF823J	5-51

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9R69		Same as 1R62	5-51
9R70		RESISTOR: MIL type RC20GF913J	5-51
9R71		Same as 1R58	5-51
9R72	P/o Z1	For Reference Only	
9R73		Same as 2R53	5-51
9R74		Same as 4R4	5-51
9R75		Same as 1R93	5-51
9R76		Same as 1R88	5-51
9R77		Same as 2R16	5-51
9S1		SWITCH, ROTARY: One section, three positions; mfr 81716, PN 96267-AA1; (Admiral PN 576C50)	5-52
9S2		SWITCH, ROTARY: Three section, ten positions; mfr 81716, PN 96625-F3; (Admiral PN 576C53)	5-51
9S3		SWITCH, ROTARY: Two sections, four positions; mfr 81716, PN 96624-F2; (Admiral PN 576C51)	5-52
9S4		Same as 1S1	5-52
9V1		Same as 1V1	5-52
9V2		Same as 2V9	5-52
9V3		Same as 1V1	5-52
9V4		ELECTRON TUBE: MIL type 6D4	5-52
9V5		Same as 2V3	5-52
9V6		Same as 2V9	5-52
9V7		Same as 1V1	5-52
9W1		CABLE ASSEMBLY: Sixteen pin connector and hook up wires; mfr 70117, PN GD2063	5-52
9XV1 thru 9XV3		Same as 1XV1	5-51
9XV4		Same as 2XV5	5-51
9XV5 thru 9XV7		Same as 1XV1	5-51
9Z1		COIL, RF: Single pi universal winding, axial leads, 140 μh; mfr 70117, PN 573B11-45	5-51
9A4		DECODER SUBASSEMBLY: Mfr 70117, PN GD4789	5-54
9A4C1		CAPACITOR: MIL type CL23CK040TN3	5-54
9A4C2		CAPACITOR: MIL type CM05D470J03	5-54
9A4C3		CAPACITOR: MIL type CM05D331J03	5-54
9A4C4		CAPACITOR: MIL type CM05D220J03	5-54
9A4C5		CAPACITOR: MIL type CM05D221J03	5-54

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9A4C6		Same as 4A2C13	5-54
9A4CR1 thru 9A4CR24		Same as 4A2CR1	5-54
9A4DL1		DELAY LINE: Assembly; mfr 70117, PN GD4788	5-54
9A4L1		Same as 4A2L1	5-54
9A4Q1 thru 9A4Q3		Same as 4A2Q1	5-54
9A4Q4		TRANSISTOR: MIL type 2N697	5-54
9A4Q5		Same as 4A2Q1	5-54
9A4Q6		Same as 4A2Q2	5-54
9A4Q7 & 9A4Q8		Same as 9A4Q4	5-54
9A4R1		RESISTOR: MIL type RC07GF822J	5-54
9A4R2		RESISTOR: MIL type RC07GF271J	5-54
9A4R3		Same as 4A2R9	5-54
9A4R4		Same as 9A4R2	5-54
9A4R5		Same as 4R120	5-54
9A4R6		RESISTOR: MIL type RC07GF392J	5-54
9A4R7		Same as 4R120	5-54
9A4R8		Same as 4R111	5-54
9A4R9		Same as 4A2R26	5-54
9A4R10		Same as 4R101	5-54
9A4R11		Same as 4A2R3	5-54
9A4R12		Same as 4R111	5-54
9A4R13		RESISTOR: MIL type RC07GF330J	5-54
9A4R14		RESISTOR: MIL type RC07GF301J	5-54
9A4R15		Same as 4R120	5-54
9A4R16		Same as 4R115	5-54
9A4R17 & 9A4R18		Same as 4A2R12	5-54
9A4R19		Same as 4A2R9	5-54
9A4R20		Same as 4R111	5-54
9A4R21		Same as 4A2R3	5-54
9A4R22		Same as 4R120	5-54
9A4R23		Same as 4R115	5-54
9A4R24		Same as 4R93	5-54

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
9A4R25		RESISTOR: MIL type RT22C2L102	5-54
9A4R26		Same as 4R92	5-54
9A4R27		RESISTOR: MIL type RT22C2L501	5-54
9A4R28		Same as 4R107	5-54
9A4R29		Same as 4R101	5-54
9A4RT1		RESISTOR, THERMISTOR: 8200 ohms, ±10%; mfr 06228, PN TM1/4-8.2KOHMPOM10PCT; (Admiral PN 561D26-9)	5-54
9A4RT2		RESISTOR, THERMISTOR: 100 ohms, ±10%; mfr 02606, PN KB21J1; (Admiral PN 561C28-3)	5-54
12		INTERCODER UNIT: Mfr 70117, PN GJ4901	5-42 thru 5-50
12A1		CLOCK-RECYCLE: Mfr 70117, PN GD4820	5-44
12A2		DELAY LINE: Module, potted; mfr 70117, PN GB4806	5-45
12A3		GENERATOR, SUBASSEMBLY: Mfr 70117, PN GD4816	5-46
12A4		GENERATOR, SUBASSEMBLY: Mfr 70117, PN GC4926	5-47
12A5		OSCILLATOR, RF: Mfr 70117, PN GJ4930	5-48
12A6		ISLS-TAG ASSEMBLY: Mfr 70117, PN GD4815	5-49
12A7		SWITCH, ASSEMBLY: Mfr 70117, PN GD4954	5-42
12A8		SWITCH, ASSEMBLY: Mfr 70117, PN GB4809	5-42
12A9		SWITCH, ASSEMBLY: Mfr 70117, PN GB4811	5-42
12A10		SWITCH, ASSEMBLY: Mfr 70117, PN GB4810	5-43
12A11		Same as 4A1	5-43
12C1		Same as 4A2C13	5-43
12C2		Same as 1C41	5-43
12C3		Same as 4A2C6	5-43
12C4		Same as 2C10	5-43
12C5 & 12C6		Same as 1C41	5-42 & 5-43
12C7		Same as 1C48	5-43
12C8 & 12C9		Same as 1C41	5-43
12C10		CAPACITOR: MIL type CL65BJ600MP3	5-42
12C11 & 12C12		Same as 12C10	5-42 & 5-43
12C13		Same as 4A2C13	5-43

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12C14 thru 12C16		Same as 12C10	5-43
12C17		Not Used	
12C18		CAPACITOR: MIL type CS13BF226K	5-42
12C19		CAPACITOR: MIL type CM05D101J03	5-42
12CR1 thru 12CR8		Not Used	
12CR9		SEMICONDUCTOR, DIODE: MIL type 1N538	5-43
12CR10		Same as 12CR9	5-43
12CR11		Not Used	
12CR12		Same as 4A2CR1	5-42
12DL1		Same as 4DL1	5-42
12E1		Same as 2E3	
12E2		SHIELD, TUBE: MIL type TS103U03	5-42
12E3		Same as 1E8	5-42
12J1 thru 12J5		Same as 1J1	5-43
12J6		Same as 9P4	5-43
12J7 thru 12J9		CONNECTOR, RECEPTACLE: Fifteen pin, dual contacts, provisions for polarization; mfr 95354, PN 80-6030-1106-00; (Admiral PN 588B247)	5-43
12J10		CONNECTOR, RECEPTACLE: Fifteen contacts, two mtg holes, 1-5/16 in. mtg centers; mfr 71468, PN DAMF-15S-C37	5-42
12J11		CONNECTOR, RECEPTACLE: 50 ohm impedance, single contact; mfr 98291, PN 52-009-0000; (Admiral PN 588B227)	5-42
12J12		Same as 9P1	5-42
12J13		CONNECTOR, RECEPTACLE: 50 ohm impedance, right angle bulkhead; mfr 98291, PN 52-012-0000; (Admiral PN 588B228)	5-42
12L1		Same as 4L27	5-42
12L2		COIL, RF: MIL type MS75053-1	5-43
12L3		Same as 12L2	5-43
12MP1		Same as 1MP24	5-39
12MP2		KNOB: Black bakelite, 23/32 in. dia, white lettering "CODE WIDTH"; mfr 70117, PN 533B99-6	5-39
12MP3		KNOB: Black bakelite, 23/32 in. dia, white lettering "ISLS WIDTH"; mfr 70117, PN 533B99-7	5-39
12MP4		KNOB: Black bakelite, 23/32 in. dia, white lettering "CODE LEVEL"; mfr 70117, PN 533B99-8	5-39

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12MP5		KNOB: Black bakelite, 23/32 in. dia, white lettering "VIDEO LEVEL"; mfr 70117, PN 533B99-9	5-39
12MP6		KNOB: Brass 1-1/4 in. dia, black finish with white lettering "SUB PULSE"; mfr 70117, PN 533B106-3	5-39
12MP7		Same as 4MP26	5-39
12MP8		KNOB: Black plastic, pointer with white lettering "ISLS"; mfr 70117, PN 533B327-2	5-39
12MP9		KNOB: Black plastic, pointer with white lettering "VIDEO"; mfr 70117, PN 533B327-3	5-39
12MP10		HINGE: 3/4 in. x 1-1/4 in. overall dim., six holes 0.093 in. dia; mfr 70117, PN 537B175	5-43
12MP11		FASTENER: Oval head with slot; mfr 72794, PN AJ3-30; (Admiral PN 513D8-1)	
12MP12		RUBBER STRIP: Black neoprene, 3/32 in. thk, 5/8 in. w, 3-1/16 in. lg; mfr 70117, PN 512D18-109	
12MP13		BUSHING, SLEEVE: 7/16 in. hex head, 0.372 in. sleeve, 1/4-32 thd thru center; mfr 70117, PN 527B851	
12MP14		Same as 9MP3	5-42
12MP15		DIAL SCALE: Aluminum 1 in. dia, light gray finish with white markings; mfr 70117, PN 525B6	5-39
12Q1		TRANSISTOR: MIL type 2N1485	5-42
12Q2		Same as 9A4Q4	5-43
12Q3		Same as 12Q1	5-42
12R1		Same as 1R93	5-42
12R2 & 12R3		Same as 1R6	5-42 & 5-43
12R4		Same as 9R45	5-43
12R5		Same as 1R23	5-42
12R6		Same as 1R6	5-43
12R7		Same as 9R45	5-42
12R8		Same as 1R62	5-43
12R9		RESISTOR, VARIABLE: Ceramic element, 100,000 ohm, ±10%; mfr 11236, PN 500R104A; (Admiral PN 575D64-1)	5-42
12R10		RESISTOR, VARIABLE: Ceramic element, first section 100,000 ohms, ±10%; second section 500 ohms ±10%; mfr 11236, PN BF63508; (Admiral PN 575D64-2)	5-42
12R11 & 12R12		Same as 3R64	5-42 & 5-43
12R13		Same as 1R62	5-43
12R14		Same as 3R57	5-43

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12R15		RESISTOR, FIXED, WW: 4000 ohm, ±5%, 25 watt, tapped at 2000 ohms ±5%; mfr 70117, PN 560A52	5-42
12R16		Same as 1R71	5-43
12R17		RESISTOR: MIL type RC32GF101J	5-43
12R18		Same as 9R26	5-43
12R19		Same as 1R54	5-43
12R20		RESISTOR: MIL type RC42GF332J	5-43
12R21		RESISTOR: MIL type RC20GF621J	5-43
12R22		RESISTOR: MIL type RC20GF910J	5-43
12R23		RESISTOR: MIL type RC20GF162J	5-43
12R24		RESISTOR: MIL type RV6LAYSA501A	5-43
12R25		Same as 12R21	5-43
12R26		Same as 2R45	5-43
12R27		RESISTOR: MIL type RC20GF152J	5-43
12R28		RESISTOR: MIL type RC20GF123K	5-43
12R29		Same as 1R88	5-42
12R30		Not Used	
12R31		Same as 2R45	5-43
12R32		Same as 12R24	5-43
12R33		Same as 2R67	5-43
12S1 thru 12S3		Same as 1S1	5-42 & 5-43
12S4		SWITCH, ROTARY: Three sections, seven positions; mfr 70117, PN 576C174	5-42
12S5		SWITCH, ROTARY: Two sections, five positions; mfr 70117, PN 576C196	5-43
12S6		SWITCH, ROTARY: Two sections, nine positions; mfr 70117, PN 576C197	5-43
12S7		SWITCH, ROTARY: Three sections, six positions; mfr 70117, PN 576C168	5-42
12S8		SWITCH, ROTARY: One section, three positions; mfr 70117, PN 576C175	5-43
12T1		TRANSFORMER, PULSE: Pulse width 1.2 μsec, rise time 0.07 μsec; mfr 01961, PN PE2988; (Admiral PN 579C25)	5-42
12T2		TRANSFORMER, POWER: Mfr 70117, PN 580D100	5-42
12TP1 thru 12TP5		Same as 2J3	5-43
12V1		Same as 5V4	5-42
12V2		Same as 2V5	5-42
12V3		Same as 5V5	5-42
12VR1		SEMICONDUCTOR, DIODE: MIL type 1N746A	5-43
12VR2		SEMICONDUCTOR, DIODE: MIL type 1N753A	5-43

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12VR3		Same as 12VR2	5-43
12VR4		SEMICONDUCTOR, DIODE: MIL type 1N963B	5-43
12XV1		Same as 1XV1	5-43
12XV2		Same as 2XV5	5-43
12XV3		Same as 1XV1	5-43
12W1		CABLE ASSEMBLY: Mfr 70117, PN GC4567	5-42
12Z1		DELAY LINE DRIVE: Mfr 70117, PN GC4741	5-42
12A1C1		Same as 4A2C6	5-44
12A1C2		Same as 2C10	5-44
12A1C3 & 12A1C4		Same as 2C13	5-44
12A1C5		CAPACITOR: MIL type CK06CW103K	5-44
12A1C6		Same as 4A2C6	5-44
12A1C7		CAPACITOR: MIL type CQ09A1MC222J3	5-44
12A1C8		CAPACITOR, VARIABLE: 1 pf to 28 pf, 1000 vdcw; mfr 73899, PN MC623Y; (Admiral PN 566C13-1)	5-44
12A1C9		Same as 2C20	5-44
12A1C10		CAPACITOR: MIL type CM06F431J03	5-44
12A1C11		CAPACITOR, FIXED, CERAMIC: 200 pf, $\pm$5%; mfr 86335, PN CK06U201J; (Admiral PN 563C29-1)	5-44
12A1C12		Same as 2C13	5-44
12A1C13		Same as 4A2C6	5-44
12A1C14		Same as 2C13	5-44
12A1C15		Same as 4A2C14	5-44
12A1C16		Same as 2C13	5-44
12A1C17		Same as 4A2C11	5-44
12A1C18		Same as 2C10	5-44
12A1C19 thru 12A1C21		Same as 4A2C13	5-44
12A1CR1 thru 12A1CR26		Same as 4A2CR1	5-44
12A1E1		PRINTED CIRCUIT BOARD: Mfr 70117, PN GB4807	5-44
12A1L1		COIL, RF: 110 μh, $\pm$5%, 0.155 in. dia, 0.375 in. lg, mfr 99800, PN 1537-78; (Admiral PN 573D50-15)	5-44
12A1L2		Same as 4A2L1	5-44
12A1L3		Same as 12A1L1	5-44

TABLE 6-2. MAINTENANCE PARTS LIST

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A1Q1 & 12A1Q2		TRANSISTOR: MIL type 2N706	5-44
12A1Q3 & 12A1Q4		Same as 9A4Q4	5-44
12A1Q5 thru 12A1Q7		Same as 12A1Q1	5-44
12A1Q8 & 12A1Q9		Same as 4A2Q2	5-44
12A1Q10 thru 12A1Q12		Same as 12A1Q1	5-44
12A1Q13 & 12A1Q14		Same as 9A4Q4	5-44
12A1Q15		Same as 12A1Q1	5-44
12A1Q16		Same as 12A1Q8	5-44
12A1Q17		Same as 12A1Q1	5-44
12A1Q18 & 12A1Q19		Same as 9A4Q4	5-44
12A1R1		Same as 4R123	5-44
12A1R2		Same as 4R120	5-44
12A1R3		Same as 4R111	5-44
12A1R4		Same as 4R109	5-44
12A1R5		Same as 4A2R26	5-44
12A1R6		Same as 4R120	5-44
12A1R7		Same as 4A2R26	5-44
12A1R8		RESISTOR: MIL type RC07GF390J	5-44
12A1R9		Same as 4R101	5-44
12A1R10		RESISTOR: MIL type RC07GF100J	5-44
12A1R11		Same as 4R101	5-44
12A1R12 thru 12A1R14		Same as 4A2R26	5-44
12A1R15		Same as 4R115	5-44
12A1R16		Same as 4R120	5-44
12A1R17		RESISTOR: MIL type RC07GF223J	5-44
12A1R18		Same as 4R120	5-44
12A1R19		Same as 4R93	5-44

TABLE 6-2. MAINTENANCE PARTS LIST

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A1R20		Same as 4A2R1	5-44
12A1R21		Same as 4R113	5-44
12A1R22		Same as 4R93	5-44
12A1R23		Same as 4R117	5-44
12A1R24		Same as 4A2R21	5-44
12A1R25		Same as 4R99	5-44
12A1R26		Same as 4R93	5-44
12A1R27		Same as 4R99	5-44
12A1R28		Same as 4A2R21	5-44
12A1R29		Same as 4R111	5-44
12A1R30		Same as 4R115	5-44
12A1R31		Same as 4A2R21	5-44
12A1R32		Same as 4R93	5-44
12A1R33		Same as 4R115	5-44
12A1R34		Same as 4A2R1	5-44
12A1R35		Same as 4R109	5-44
12A1R36 thru 12A1R38		Same as 4R101	5-44
12A1R39		Same as 12A1R10	5-44
12A1R40		RESISTOR: MIL type RC07GF470J	5-44
12A1R41		Same as 4R107	5-44
12A1R42		Same as 4R123	5-44
12A1R43		Same as 4R101	5-44
12A1R44		RESISTOR: MIL type RC07GF561J	5-44
12A1R45		Same as 4R107	5-44
12A1R46		Same as 4R101	5-44
12A1R47		Same as 4R115	5-44
12A1R48		Same as 9A4R6	5-44
12A1R49		Same as 4A2R9	5-44
12A1R50		Same as 4A2R1	5-44
12A1R51		Same as 4A2R21	5-44
12A1R52		Same as 4A2R9	5-44
12A1R53 & 12A1R54		Same as 4R115	5-44
12A1R55		Same as 4R101	5-44
12A1R56		Same as 4A2R26	5-44

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A1R57		Same as 12A1R10	5-44
12A1R58		Same as 12A1R17	5-44
12A1R59		Same as 4A2R30	5-44
12A1RT1		RESISTOR, THERMISTOR: 500 ohms, ±10%, 1/4 watt; mfr 06228, PN TM1/4-500OHMPORM10PCT; (Admiral PN 561D26-13)	5-44
12A1T1 & 12A1T2		TRANSFORMER, PULSE: Primary dc resistance 0.41 ohms, secondary dc resistance 0.45 ohms, pulse width 0.05 μsec; mfr 97722, PN TT-101-0.05; (Admiral PN 579D46-3)	5-44
12A1TP1 thru 12A1TP5		Same as 2J3	5-44
12A2DL1		DELAY LINE: Potted 11/32 in. thk, 3-1/8 in. w, 4-1/8 in. lg, delay time range 2 μsec to 25 μsec; mfr 70117, PN 572D39	5-45
12A2R1		Same as 4R103	5-45
12A2TP1 & 12A2TP2		Same as 2J3	5-45
12A3CR1 & 12A3CR2		Not Used	
12A3CR3 thru 12A3CR10		Same as 4A2CR1	5-46
12A3CR11 & 12A3CR12		Not Used	
12A3CR13 thru 12A3CR78		Same as 4A2CR1	5-46
12A3E1		PRINTED CIRCUIT BOARD: Mfr 70117, PN GB4944	5-46
12A3R1		Not Used	
12A3R2		Same as 9A4R6	5-46
12A3R3		Same as 4A2R1	5-46
12A3R4		Same as 9A4R6	5-46
12A3R5		Not Used	
12A3R6 & 12A3R7		Same as 4A2R1	5-46
12A3R8 & 12A3R9		Same as 9A4R6	5-46
12A3R10		Same as 4A2R1	5-46
12A3R11 & 12A3R12		Same as 9A4R6	5-46

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A3R13 thru 12A3R21		Same as 4A2R1	5-46
12A3R22		Same as 9A4R6	5-46
12A3R23		Same as 4A2R1	5-46
12A3R24		Same as 9A4R6	5-46
12A3R25		Same as 4A2R1	5-46
12A3R26 & 12A3R27		Same as 9A4R6	5-46
12A4C1		Not Used	
12A4C2		CAPACITOR: MIL type CK06CW472K	5-47
12A4C3		Same as 2C13	5-47
12A4C4		Same as 2C18	5-47
12A4C5		Same as 4A2C3	5-47
12A4C6		Same as 12A1C5	5-47
12A4C7		CAPACITOR: MIL type CK60AW471K	5-47
12A4C8 & 12A4C9		Same as 2C13	5-47
12A4CR1 thru 12A4CR3		Not Used	
12A4CR4 thru 12A4CR8		Same as 4A2CR1	5-47
12A4CR9		Not Used	
12A4CR10		Same as 4A2CR1	5-47
12A4E1		PRINTED CIRCUIT BOARD: Mfr 70117, PN GB4927	5-47
12A4L1		COIL, RF: MIL type MS18130-26	5-47
12A4Q1 & 12A4Q2		Same as 12A1Q1	5-47
12A4Q3 & 12A4Q4		Same as 9A4Q4	5-47
12A4Q5 & 12A4Q6		Same as 12A1Q1	5-47
12A4Q7 & 12A4Q8		Same as 9A4Q4	5-47
12A4R1		Same as 4R115	5-47

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A4R2		RESISTOR: MIL type RC07GF220J	5-47
12A4R3		Same as 4A2R1	5-47
12A4R4		Same as 12A1R17	5-47
12A4R5		Not Used	
12A4R6		Same as 4R111	5-47
12A4R7		Same as 4R92	5-47
12A4R8		Same as 12A1R40	5-47
12A4R9		Same as 4A2R1	5-47
12A4R10		Same as 4A2R26	5-47
12A4R11		Same as 4R115	5-47
12A4R12		Same as 4A2R1	5-47
12A4R13		Same as 4R101	5-47
12A4R14		RESISTOR: MIL type RC07GF680J	5-47
12A4R15		Same as 12A1R10	5-47
12A4R16		Same as 4A2R26	5-47
12A4R17		Same as 4R101	5-47
12A4R18		Same as 4R99	5-47
12A4R19		Same as 12A1R10	5-47
12A4R20		Same as 4R115	5-47
12A4R21		Same as 12A1R40	5-47
12A4T1		TRANSFORMER, PULSE: Primary dc resistance 0.267 ohms, secondary dc resistance 0.282 ohms, tertiary dc resistance 0.298 ohms, pulse width 0.025 μsec; mfr 70117, PN 579D46-5	5-47
12A4T2		TRANSFORMER, PULSE: Primary dc resistance 1.3 ohms, secondary dc resistance 1.4 ohms, tertiary dc resistance 1.5 ohms, pulse width 0.1 μsec; mfr 70117, PN 579D46-1	5-47
12A5C1		CAPACITOR, FIXED, CERAMIC: Feed thru, 1000 pf +80% -20%, 500 vdcw; mfr 72872, PN 2482001-S-W5V0-102Z; (Admiral PN 563C24-1)	5-48
12A5C2		Same as 4A2C14	5-48
12A5C3		Same as 2C8	5-49
12A5C4		CAPACITOR: MIL type CM05C180K03	5-49
12A5C5		CAPACITOR, VARIABLE: Piston type, 1.0 pf to 10.0 pf, 500 vdcw; mfr 73899, PN VC-950; (Admiral PN 566C8-2)	5-49
12A5C6		Same as 2C13	5-49
12A5C7		Not Used	
12A5C8		Same as 12A1C5	5-48
12A5C9		CAPACITOR, VARIABLE: Piston type, 1.0 pf to 10.0 pf, 500 vdcw; mfr 73899, PN VCJ-2109; (Admiral PN 566C8-6)	5-49
12A5C10		Same as 2C13	5-49
12A5C11		Not Used	

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A5C12		Same as 12A5C9	5-49
12A5C13		Same as 2C13	5-49
12A5C14		CAPACITOR, FIXED, CERAMIC: Feed thru type, 100 pf, +20%, 300 vdcw; mfr 72982, PN 2482-001GMV-101Z; (Admiral PN 563C24-3)	5-48
12A5C15		Same as 2C13	5-49
12A5C16		Not Used	
12A5C17		Same as 4A2C13	5-48
12A5C18		Same as 12A5C1	5-48
12A5C19		CAPACITOR, VARIABLE: Piston type, 1.0 pf to 10.0 pf, 500 vdcw; mfr 73899, PN VCJ-1839; (Admiral PN 566C8-3)	5-49
12A5C20		Not Used	
12A5C21		Not Used	
12A5C22		Same as 12A5C5	5-49
12A5C23		Same as 12A5C19	5-49
12A5C24		Same as 12A5C9	5-49
12A5C25		CAPACITOR, VARIABLE: Piston type, 0.8 pf to 4.5 pf, 500 vdcw; mfr 73899, PN VCJ-6795; (Admiral PN 566C8-4)	5-49
12A5C26		Same as 12A5C9	5-49
12A5C27		Same as 12A5C1	5-48
12A5C28		Same as 12A5C9	5-48
12A5C29		Same as 12A5C5	5-49
12A5C30		Same as 12A5C1	5-48
12A5C31		Same as 9C36	5-48
12A5C32		Same as 12A5C25	5-49
12A5C33		Same as 12A5C9	5-48
12A5C34 & 12A5C35		Same as 12A5C1	5-48
12A5C36		CAPACITOR: MIL type CS13BE106K	5-48
12A5C37 thru 12A5C39		Same as 12A5C1	5-48
12A5C40		CAPACITOR: MIL type CK60AX331K	5-48
12A5C41		Same as 12A5C1	5-48
12A5C42		Same as 12A1C5	5-48
12A5CR1 & 12A5CR2		Not Used	
12A5CR3		Same as 4A2CR1	5-48
12A5CR4		SEMICONDUCTOR, DIODE: MIL type MA4325E	5-49

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A5CR5		SEMICONDUCTOR, DIODE: Mfr 96341, PN MA4325D; (Admiral PN 593B79-2)	5-49
12A5CR6		SEMICONDUCTOR, DIODE: MIL type MA4326D1	5-49
12A5E1		SCREW, MOUNTING: 4-17/32 in. lg, 6-32 x 9/32 in. thd, 7/32 in. dia x 1/4 in. lg head; mfr 70117, PN 527C721-7	
12A5J1		CONNECTOR, RECEPTACLE: Fifteen contacts, two mtg holes 1-5/16 in. mtg centers; mfr 71468, PN DAM-15P-C37; (Admiral PN 588D164-15)	5-49
12A5J2		CONNECTOR, RECEPTACLE: Single contact, 10-32 x 17/64 in. thd for mtg; mfr 98291, PN 52-046-0069; (Admiral PN 588C220)	5-49
12A5L1		COIL, RF: 3/32 in. dia, 1/4 in. lg, 1.5 μh, $\pm$10%; mfr 99800, PN 1025-24; (Admiral PN 573D72-13)	5-49
12A5L2		COIL, RF: Toroid, 9-3/4 turns of no. 20 awg wire; mfr 70117, PN 569B90	5-49
12A5L3 & 12A5L4		COIL, RF: Air core, 8-1/2 turns of no. 20 awg wire, 3/16 in. dia; mfr 70117, PN 569B93	5-49
12A5L5		COIL, RF: Air core, 2-1/2 turns of no. 20 awg wire, 3/16 in. dia, 1/4 in. lg; mfr 70117, PN 569B94	5-49
12A5L6		COIL, RF: Air core, 2 turns of no. 16 awg wire, 3/8 in. dia, 3/16 in. lg; mfr 70117, PN 569B101	5-49
12A5L7		COIL, RF: Air core, 14-1/2 turns of no. 24 awg wire, 1/8 in. dia; mfr 70117, PN 569B100	5-49
12A5L8		COIL, RF: Air core, 8-1/2 turns of no. 24 awg wire, 1/8 in. dia, 7/16 in. lg; mfr 70117, PN 569B95	5-49
12A5L9		COIL, RF: 3/32 in. dia, 1/4 in. lg, 0.22 μh, $\pm$10%; mfr 99800, PN 1025-04; (Admiral PN 573D72-3)	5-49
12A5L10		Same as 12A5L9	5-49
12A5L11 & 12A5L12		Same as 12A5L8	5-49
12A5L13		Same as 12A5L7	5-49
12A5L14		Same as 4A2L1	5-49
12A5MP1		PAD, TRANSISTOR: Nylon 0.032 in. thk, 0.187 in. dia, four 0.030 in. holes; mfr 08289, PN FP-10; (Admiral PN 533B320)	
12A5Q1 & 12A5Q2		Same as 4A2Q1	5-49
12A5Q3		TRANSISTOR: MIL type 2N2222	5-49
12A5Q4		TRANSISTOR: MIL type 2N3553	5-49
12A5Q5		Same as 9A4Q4	5-48
12A5R1		Same as 4R109	5-48
12A5R2		Same as 4R115	5-48
12A5R3		Same as 4R97	5-48
12A5R4		Same as 4R101	5-48

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A5R5 thru 12A5R7		Not Used	
12A5R8		RESISTOR: MIL type RC07GF681J	5-48
12A5R9 & 12A5R10		Same as 1R65	5-49
12A5R11		Same as 12A5R8	5-48
12A5R12		RESISTOR: MIL type RC07GF393J	5-49
12A5R13		Same as 12A5R8	5-48
12A5R14		Same as 4A2R26	
12A5R15		Same as 9A4R6	
12A5R16		Same as 4R107	
12A5T1		TRANSFORMER, RF: Toroid, primary 5-3/4 turns, secondary 1-3/4 turns, no. 22 awg wire; mfr 70117, PN 573B74	5-49
12A5T2		TRANSFORMER, RF: Toroid, primary 7-3/4 turns, secondary 2-3/4 turns, no. 22 awg wire; mfr 70117, PN 573B70	5-49
12A5T3		TRANSFORMER, RF: Toroid, primary 7-1/2 turns, tap at 5-1/4 turns, secondary 1-3/4 turns, no. 22 awg wire; mfr 70117, PN 573B71	5-49
12A5T4		Not Used	
12A5T5		Not Used	
12A5T6A		TRANSFORMER, RF: Air core, (primary) 2 turns 3/8 in. dia, no. 16 awg wire; mfr 70117, PN 569B97	5-49
12A5T6B		TRANSFORMER, RF: Air core, (secondary) 1-3/4 turns 3/8 in. dia, no. 16 awg wire; mfr 70117, PN 569B98	5-49
12A5V1		ELECTRON, TUBE: Mfr 95303, PN 8627	5-49
12A5XV1 & 12A5XV2		SOCKET, TUBE: Nuvistor, five contacts; mfr 71785, PN 133-65-10-041; (Admiral PN 587C105)	5-49
12A5Y1		CRYSTAL, UNIT: MIL type CR56A/U85.833	5-49
12A5Z1		ANODE, LINE ASSEMBLY: Mfr 70117, PN GC4476-2	
12A6C1		Same as 2C10	5-50
12A6C2		Same as 3C1	5-50
12A6C3		Same as 12C19	5-50
12A6C4		CAPACITOR: MIL type CQ09A1MC472J3	5-50
12A6C5		Same as 2C10	5-50
12A6C6		Same as 4A2C13	5-50
12A6C7 & 12A6C8		Same as 2C13	5-50
12A6C9		CAPACITOR: MIL type CSR13G473KL	5-50

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A6C10		Same as 2C10	5-50
12A6C11		Same as 2C39	5-50
12A6C12		Same as 4C9	5-50
12A6C13		Same as 12C19	5-50
12A6C14 & 12A6C15		Same as 2C10	5-50
12A6C16		CAPACITOR: MIL type CK60AW152M	5-50
12A6C17		Same as 4A2C13	5-50
12A6C18		Same as 12A6C16	5-50
12A6C19		Same as 12A1C5	5-50
12A6C20		CAPACITOR: MIL type CSR13G472KL	5-50
12A6C21		Same as 2C13	5-50
12A6C22		Same as 4A2C14	5-50
12A6C23 & 12A6C24		Same as 4A2C13	5-50
12A6CR1 thru 12A6CR25		Same as 4A2CR1	5-50
12A6E1		PRINTED CIRCUIT BOARD: Mfr 70117, PN GB4808	5-50
12A6L1		Same as 4A2L1	5-50
12A6Q1 thru 12A6Q8		Same as 12A1Q1	5-50
12A6Q9 thru 12A6Q11		Same as 9A4Q4	5-50
12A6Q12 thru 12A6Q14		Same as 12A1Q1	5-50
12A6Q15		Same as 9A4Q4	5-50
12A6Q16 thru 12A6Q19		Same as 12A1Q1	5-50
12A6Q20		Same as 9A4Q4	5-50
12A6Q21		TRANSISTOR: MIL type 2N1132	5-50
12A6Q22 thru 12A6Q24		Same as 9A4Q4	5-50
12A6Q25 & 12A6Q26		Same as 12A1Q1	5-50

TABLE 6-2. MAINTENANCE PARTS LIST

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A6R1		Same as 4A2R21	5-50
12A6R2		Same as 4A2R26	5-50
12A6R3		Same as 4R101	5-50
12A6R4		Same as 4A2R21	5-50
12A6R5		Same as 4A2R26	5-50
12A6R6		Same as 4R101	5-50
12A6R7 & 12A6R8		Same as 4A2R1	5-50
12A6R9 & 12A6R10		Same as 4R120	5-50
12A6R11		RESISTOR: MIL type RT10C2L102	5-50
12A6R12		Same as 4R93	5-50
12A6R13		Same as 4R92	5-50
12A6R14		Same as 4R115	5-50
12A6R15		Same as 4R120	5-50
12A6R16		Same as 4R111	5-50
12A6R17		Same as 4R120	5-50
12A6R18		Same as 4A2R21	5-50
12A6R19		Same as 4R107	5-50
12A6R20		Same as 4R115	5-50
12A6R21		Same as 12A6R11	5-50
12A6R22		Same as 4R113	5-50
12A6R23		RESISTOR: MIL type RC07GF273J	5-50
12A6R24		RESISTOR: MIL type RC07GF183J	5-50
12A6R25		Same as 4R120	5-50
12A6R26		Same as 4A2R21	5-50
12A6R27		Same as 4R109	5-50
12A6R28		Same as 4A2R26	5-50
12A6R29		Same as 9A4R6	5-50
12A6R30 & 12A6R31		Same as 4R101	5-50
12A6R32		Same as 12A1R10	5-50
12A6R33 & 12A6R34		Same as 4R92	5-50
12A6R35		Same as 4A2R26	5-50

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A6R36		Same as 4R101	5-50
12A6R37		Same as 2R51	5-50
12A6R38		Same as 4A2R26	5-50
12A6R39		Same as 4R115	5-50
12A6R40		Same as 4R117	5-50
12A6R41		Same as 12A6R23	5-50
12A6R42		Same as 4A2R9	5-50
12A6R43		Same as 4R120	5-50
12A6R44		Same as 4A2R12	5-50
12A6R45 & 12A6R46		Same as 4A2R1	5-50
12A6R47		Same as 4R117	5-50
12A6R48		Same as 4A2R26	5-50
12A6R49		Same as 2R45	5-50
12A6R50		Not Used	
12A6R51		Same as 4R120	5-50
12A6R52		Same as 4R101	5-50
12A6R53		Same as 4A2R12	5-50
12A6R54		Same as 4A2R21	5-50
12A6R55		Same as 4R111	5-50
12A6R56 & 12A6R57		Same as 4R115	5-50
12A6R58		Same as 4A2R30	5-50
12A6R59 & 12A6R60		Same as 1R65	5-50
12A6R61		Same as 4A2R30	5-50
12A6R62		Same as 4R115	5-50
12A6R63		Same as 12A1R10	5-50
12A6R64		Same as 4A2R3	5-50
12A6R65 & 12A6R66		Same as 4R115	5-50
12A6R67		Same as 4A2R3	5-50
12A6R68		Same as 12A5R8	5-50
12A6R69		RESISTOR: MIL type RT10C2L501	5-50
12A6R70		Same as 4R111	5-50

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

CODER SIMULATOR SM-197A/UPM-98

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
12A6R71		Same as 4A2R26	5-50
12A6R72		Same as 4A2R1	5-50
12A6R73		Same as 4R111	5-50
12A6R74		Same as 4A2R26	5-50
12A6R75		Same as 4R111	5-50
12A6R76		RESISTOR: MIL type RT10C2L502	5-50
12A6R77		Same as 4A2R9	5-50
12A6R78		Not Used	
12A6R79		RESISTOR: MIL type RC07GF153J	5-50
12A6R80		Same as 9A4R6	5-50
12A6R81		Same as 4R101	5-50
12A6R82		Same as 4R109	5-50
12A6R83		Same as 4R111	5-50
12A6R84		Same as 4A2R1	5-50
12A6T1		Same as 12A1T1	5-50

TABLE 6-2. MAINTENANCE PARTS LIST (Cont.)

ACCESSORIES

REF DESIG	NOTES	NAME AND DESCRIPTION	FIG NO.
11		ACCESSORIES	
11A1		PRINTED CIRCUIT TEST BOARD: Mfr 70117, PN GB4825	1-5
11CP1		ADAPTER, CONNECTOR: MIL type UG-309/U	1-5
11CP2		ADAPTER, CONNECTOR: MIL type UG-201A/U	1-5
11CP3		ADAPTER, CONNECTOR: MIL type UG-273/U	1-5
11CP4		ADAPTER, CONNECTOR: MIL type UG-636A/U	1-5
11CP5		ADAPTER, CONNECTOR: MIL type UG-274B/U	1-5
11E1		SHIELD, CONNECTOR: Mfr 70117, PN 533D264-1	1-5
11E2		SHIELD, CONNECTOR: Mfr 70117, PN 533D264-2	1-5
11MP1		VISOR, CATHODE-RAY TUBE: MX2953/UPM; Mfr 70117, PN 512D144-3	1-5
11MP2		CLAMP, VISOR: Stainless steel, 0.025 in. thk, 1/2 in. w, 15-1/4 in. lg, with worm drive screw; mfr 70117, PN 511B44	1-5
11MP3		KEY CONNECTOR: MIL type M21097/11-02	1-5
11MP4		CASE, ACCESSORY CY-2725/UPM-98: Mfr 70117, PN GJ1994-2	1-5
11P1		Same as 1P2	1-5
11P2		Same as 5J2	1-5
11P3		Same as 9P1	1-5
11P4		Same as 8J22	1-5
11P5		Same as 8P4	1-5
11P6		Same as 8P19	1-5
11P7		DUMMY LOAD, ELECTRICAL: Type no. DA-232/U; mfr 70117, PN588B87-2	1-5
11P8		CONNECTOR, RECEPTACLE: Fifteen pin, dual contacts; mfr 95354, PN 80-6030-3406-00; (Admiral PN 588B246)	1-5
11R1		Same as 1R34	1-5
11W1		CABLE ASSEMBLY, SPECIAL PURPOSE ELECTRICAL: CX-4963/UPM; mfr 70117, PN GD2530-6	1-7
11W2		CABLE ASSEMBLY, SPECIAL PURPOSE ELECTRICAL: CX-6092/U(3FT); mfr 70117, PN GD2531-3	1-7
11W3		CABLE ASSEMBLY, SPECIAL PURPOSE ELECTRICAL: CX-4964/UPM; mfr 70117, PN GD2392-4	1-7
11W4		CABLE ASSEMBLY, RADIO FREQUENCY: CG409E/U(5FT2IN); mfr 70117, PN GC2026-25	1-7
11W5		CABLE ASSEMBLY, RADIO FREQUENCY: CG409E/U(10FT2IN); mfr 70117, PN GC2026-26	1-7
11W6		CABLE ASSEMBLY, RADIO FREQUENCY: CG503F/U(5FT2IN); mfr 70117, PN GC2026-27	1-7
11W7		CABLE ASSEMBLY, RADIO FREQUENCY: CG530F/U(10IN); mfr 70117, PN GC2026-28	1-7
11W8		CABLE ASSEMBLY, RADIO FREQUENCY: CG1848/U(6IN); mfr 70117, PN GC2026-29	1-7
11W9		CABLE ASSEMBLY, RADIO FREQUENCY: CG3380/U(3FT); mfr 70117, PN GB4751-2	1-7

TABLE 6-3. LIST OF MANUFACTURERS

MFR CODE	NAME	ADDRESS
00656	Aerovox Corporation	New Bedford, Mass.
01121	Allen-Bradley Company	Milwaukee, Wisc.
01961	Pulse Engineering Inc.	Santa Clara, Calif.
02598	Rotating Components Inc.	Brooklyn, N.Y.
02606	Fenwal Laboratories	Morton Grove, Ill.
02660	Amphenol-Borg Corporation	Maywood, Ill.
04239	General Electric Co. (Metallurgical Products Dept.)	Edmore, Mich
04713	Motorola Inc. (Semiconductor Div.)	Phoenix, Arizona
06228	Texas Instrument Inc.	Dallas, Texas
07344	Burcher Co. Inc.	Rochester, N.Y.
07387	The Birtcher Corporation	Los Angeles, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
08289	Blinn Delbert Co. Inc.	Pomona, Calif.
11236	CTS of Berne Inc.	Berne, Ind.
14655	Cornell-Dubilier Electric Corporation	Newark, N.J.
15605	Cutler-Hammer Inc.	Milwaukee, Wisc.
18911	Durant Mfg Co.	Milwaukee, Wisc.
20183	General Atronics Corporation	Philadelphia, Pa.
24455	General Electric Co. (Lamp Div. of Consumer Products Group)	Nela Park, Cleveland, Ohio
56289	Sprague Electric Co.	North Adams, Mass.
57068	Stanley Works	New Britain, Conn.
57711	Stewart FW Corporation	Chicago, Ill.
70117	Admiral Corporation	Chicago, Ill.
70485	Atlantic India Rubber Works Inc.	Chicago, Ill.
71279	Cambridge Thermionic Corporation	Cambridge, Mass.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corporation	Chicago, Ill.
71450	CTS Corporation	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71590	Centralab Div. of Globe-Union Inc.	Milwaukee, Wisc.
71616	Commercial Plastic Company	Chicago, Ill.
71785	Cinch Mfg Company	Chicago, Ill.
72136	The Electro Motive Mfg Co. Inc.	Willimantic, Conn.
72619	Dialight Corporation	Brooklyn, N.Y.
72794	Dzus Fastener Co. Inc.	West Islip, N.Y.
72825	Eby Hugh Inc.	Philadelphia, Pa.

TABLE 6-3. LIST OF MANUFACTURERS (Cont.)

MFR CODE	NAME	ADDRESS
72872	Grado Colloids Corporation	Sharon, Pa.
72928	Gudeman Company	Chicago, Ill.
72982	Erie Resistor Corporation	Erie, Pa.
73326	CBS Hytron Div. of Columbia Broadcasting System Inc.	Salem, Mass.
73899	J. F. D. Electronics Corporation	Brooklyn, N. Y.
74868	FXR Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
75042	International Resistance Co.	Philadelphia, Pa.
75376	Kurz-Kasch Inc.	Dayton, Ohio
75543	Lavelle Rubber Co.	Chicago, Ill.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Mfg Co.	Crystal Lake, Ill.
77969	Rubbercraft Corp. of Calif. Ltd.	Torrance, Calif.
78189	Shakeproof Div. of Illinois Tool Works	Elgin, Ill.
78616	Latrobe Plant of Refractories Div. of Carborundum Co.	Latrobe, Pa.
79136	Waldes Kohinoor Inc.	Long Island City, N. Y.
80033	Prestole Fastener Div. Bishop and Babcock Corp.	Toledo, Ohio
81312	Winchester Electronics Division Litton Industries Inc.	Oakville, Conn.
81716	Oak Mfg Co.	Crystal Lake, Ill.
82866	Research Products Corporation	Madison, Wisc.
84970	Sarkes Tarzian Inc.	Bloomington, Ind.
86335	Glenco Corporation	Metuchen, N. J.
91662	Elco Corporation	Willow Grove, Pa.
92172	Torrington Specialty Mfg Co. Inc.	Torrington, Conn.
92825	Whitso Inc.	Schiller Park, Ill.
93110	Hopkins Engineering Co.	Altadena, Calif.
94222	South Chester Corporation	Chester, Pa.
94375	Automatic Metal Products Co.	Brooklyn, N. Y.
95303	Radio Corp. of America Commercial Receiving Tube and Semiconductor Division	Cincinnati, Ohio
95354	Methode Manufacturing Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96188	Precision Rubber Products Corporation	Chicago, Ill.
97722	PCA Electronics Inc.	Sepulveda, Calif.
98278	Microdot Inc.	South Pasadena, Calif.
98291	Sealectro Corporation	Mamaroneck, N. Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99120	Plastic Capacitors Inc.	Chicago, Ill.
99800	Delevan Electronics Corporation	East Aurora, N. Y.

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